DRAFT #5

Bryant Creek: Total Maximum Daily Loads – Arsenic, Copper, Iron, Nickel, Turbidity, Total Suspended Solids and Temperature

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1.0 Introduction

1.1 Section 303(d) of the Clean Water Act (CWA)

Section 303(d) of the Clean Water Act requires each state to develop a list of water bodies that need additional work beyond existing controls to achieve or maintain water quality standards, and submit an updated list to the Environmental Protection Agency (EPA) every two years. The Section 303(d) List provides a comprehensive inventory of water bodies impaired by all sources. This inventory is the basis for targeting water bodies for watershed-based solutions, and the TMDL process provides an organized framework to develop these solutions.

1.2 Total Maximum Daily Load (TMDL) Defined

TMDLs are an assessment of the amount of pollutant a water body can receive and not violate water quality standards, and provide a means to integrate the management of both point and nonpoint sources of pollution through the establishment of waste load allocations for point source discharges and load allocations for nonpoint sources. For pollutants other than heat, TMDLs are to be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with consideration given to seasonal variations and a margin of safety. Once approved by the U.S. Environmental Protection Agency, TMDLs are implemented through existing National Pollutant Discharge Elimination System (NPDES) permits for point source discharges to achieve the necessary pollutant reductions. Non point source TMDLs can be implemented through voluntary or regulatory nonpoint source control programs, depending on the state. In Nevada, the nonpoint source program is voluntary.

Bryant Creek was initially included on Nevada's 1998 303(d) List due to water quality concerns related to copper, iron and nickel. With the 2002 303(d) List, the Bryant Creek listing has been expanded to include arsenic, turbidity, total suspended solids and temperature.

1.3 A Phased Approach to TMDL Adoption and Implementation

This document presents a "phased" approach to TMDL adoption and implementation, for the parameters listed above. A phased approach is used in situations where data and information needed to determine the TMDL and associated load allocations are limited. A phased approach enables the adoption and implementation of a TMDL while collecting additional information ("*Guidance for Water Quality Based Decisions—The TMDL Process*" (#EPA 440/4-91-001, April 1991)).

Under the phased approach, the TMDL has Load Allowances (LAs) and Waste Load Allowances

(WLAs) calculated with margins of safety to meet water quality standards. The allocations are based on estimates, which use available data and information, however, monitoring for the collection of new data is required. The phased approach provides for ongoing pollution reduction without waiting for new data collection and analysis. The margin of safety developed for the TMDL under the phased approach reflects the adequacy of data and the degree of uncertainty about the relationship between load allocations and receiving water quality.

A phased approach TMDL includes (1) WLAs that confirm existing limits or would lead to new limits for point sources and (2) LAs that confirm existing controls or include implementing new controls for non point sources. This type of TMDL requires additional data to be collected to determine if the load reductions required by the TMDL lead to attainment of water quality standards. Data collection may also be required to more accurately determine assimilative capacities and pollution allocations.

In addition to the allocations for point and non point sources, TMDLs adopted under the phased approach generally establish a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, the assessment for water quality standards attainment, and, if needed, additional predictive modeling. The intent of this scheduling is to coordinate the various activities (i.e. permitting, monitoring, modeling) and involve the appropriate authorities from local, State and Federal agencies. The schedule for the installation and implementation of control measures and their subsequent evaluations requires descriptions of the types of controls, the expected pollutant reductions, and the time frame within which water quality standards will be met and controls re-evaluated.

Where no monitoring program exists, or where additional assessments are needed, States must design and implement a monitoring plan. The objectives of the monitoring program should include assessment of water quality standards attainment, verification of pollution source allocations, calibration/modification of selected models, calculation of dilutions and pollutant mass balances, and evaluation of point and non point source control effectiveness. As part of the monitoring program, a description of data collection methodologies and quality assurance/quality control procedures, a review of current discharger monitoring reports, should be integrated with volunteer and cooperative monitoring programs where possible. If properly designed and implemented, the monitoring program will result in a sufficient database for assessment of water quality standard attainment and additional predictive modeling if necessary.

2.0 Background

2.1 Study Area

Bryant Creek is a tributary of the East Fork Carson River. The creek originates in California on the eastern slopes of the Sierra Nevada Mountains in northeast Alpine County. As shown in Figure 1, Mountaineer Creek and Leviathan Creek combine to form Bryant Creek. For over 50 years, acid mine drainage from the Leviathan Mine has impacted the waters of Leviathan and Bryant creeks, creating significant water quality concerns. This drainage is primarily the result of repeated failure of the tailings impoundment walls and pond overflow.

2.1.1. Leviathan Mine and its Impact on Water Quality

The Leviathan Mine is located approximately eight miles east of Markleeville, California and ten miles west of Holbrook Junction, Nevada, off California SR-89. Underground development of the mine site began in 1863 in an effort to exploit the large deposits of copper sulfate minerals present. Since the time of ancient Greece and Rome, the prevailing metallurgical practice was to add copper sulfate to ground metal sulfide ores, in an effort to make these ores more amenable to mercury amalgamation and metal recovery. Although this recovery method was practiced on the Comstock silver ores in Virginia City, Nevada, it was not all that common. Because of the unique mineralogy of the Comstock silver ores, the actual effectiveness of copper sulfate as a process aid was limited at best and the practice was eventually discontinued.

The Leviathan Mine operated intermittently until 1872, never becoming the huge bonanza as envisioned by its investors. The copper sulfate minerals were often intermixed with complex sulfide minerals, making any economical separation and recovery difficult. Furthermore, poor structural geology, compounded by ground water infiltration an inadequate mine dewatering, resulted in numerous underground wall failures and repeated sub-level flooding at the mine.

From 1872 to 1935 the mine remained inactive, only to be reopened for the development of the sulfur body. The mine was closed in 1941, however in 1951, the Anaconda Company (now a subsidiary of ARCO) purchased the property with the intent of transforming the underground workings into an open pit mine (U.S. EPA, November 1999). Approximately 22 million tons of overburden and waste rock were removed in the process, most of which was used to divert the flows of Leviathan and Aspen creeks (U.S. EPA, May 2000). This flow diversion has resulted in an increase in the amount of acidic mine waters and dissolved metals entering Leviathan and Bryant Creek. As shown on Figure 1, contaminants in Leviathan Creek also enter Bryant Creeks as well as the East Fork and Main Fork of the Carson River (U.S. EPA, November 1999).

The California Regional Water Quality Control Board (Regional Board) acquired the site in 1984 and began working on actions to reduce acid mine drainage problems. Work has included filling and grading the mine pit and waste rock piles, channelizing Leviathan Creek, vegetating the site, and constructing evaporation ponds to capture the acid mine drainage (AMD). During periods of spring snowmelt and heavy rains, AMD entered Leviathan Creek as evaporation ponds overflowed. In 1998, additional pond storage was constructed but was not sufficient to prevent the ponds from overflowing during spring runoff in 1999. Following that incident, the Regional Board began treating water in the ponds with lime to neutralize the acid mine drainage and reduce the concentration of metals in solution. As pH of a solution increases (e.g. becomes more neutral), metals ions in solution are selectively removed (e.g. precipitated) from solution as insoluble metal hydroxides

On May 11, 2000, Leviathan Mine was officially designated as a Superfund site. This designation will bring a long-term plan and Federal attention to the problem. Superfund designation will bring a sense of accountability to the cleanup efforts, which are the responsibility of the ARCO Environmental Group. Although ARCO has been relieved of any liability, the company will carry most of the financial burden for the Superfund cleanup (Las Vegas Sun, September 13, 2000).

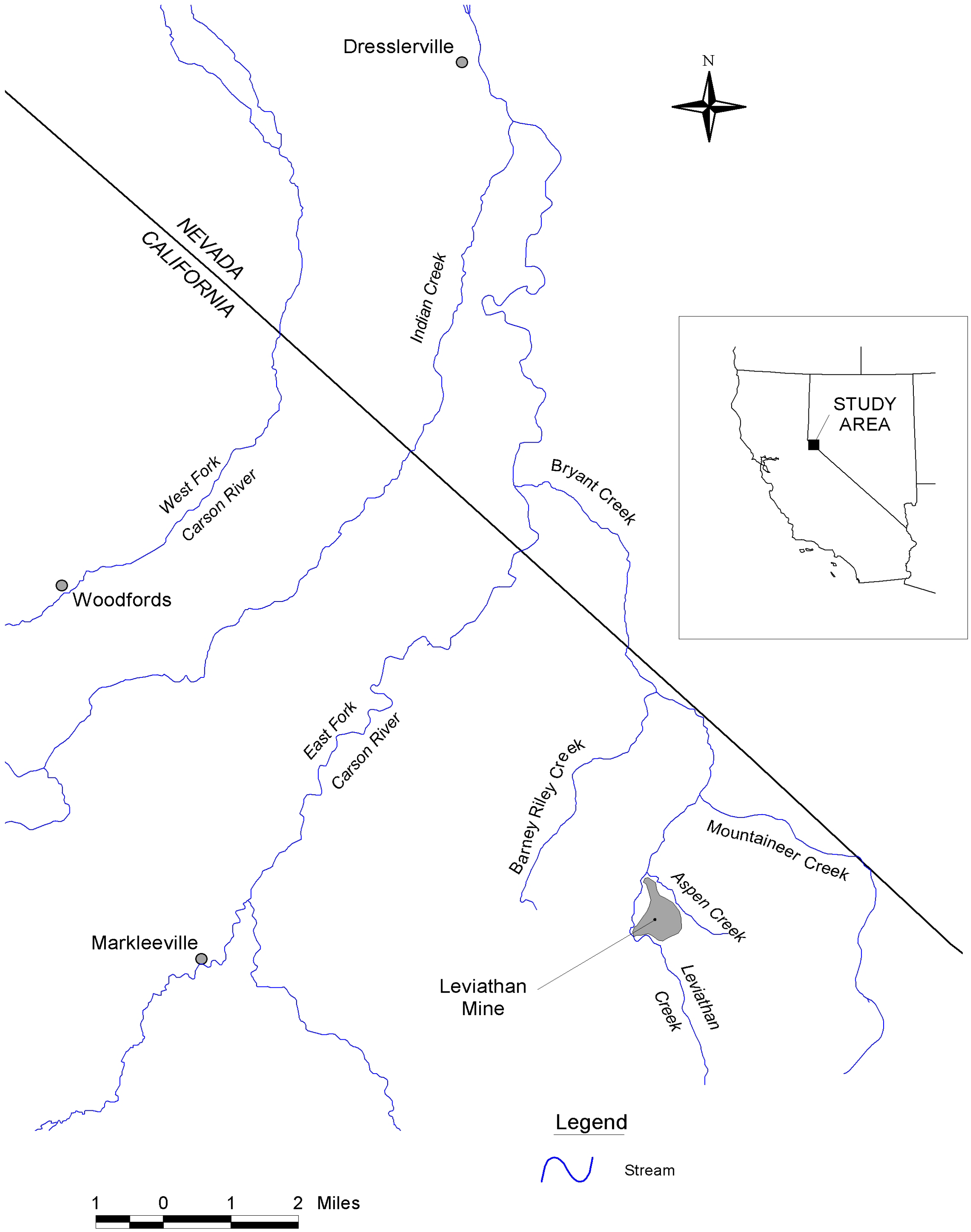


Figure 1. Bryant Creek Location Map

2.2 Water Quality Standards

Nevada's water quality standards, contained in the Nevada Administrative Code 445A.119 – 445A.225, define the water quality goals for a water body by: 1) designating beneficial uses of the water; and 2) setting criteria necessary to protect the beneficial uses. Beneficial uses include such things as irrigation, recreation, aquatic life, fisheries, irrigation and drinking water. The designated beneficial uses for Bryant Creek include:

- Irrigation
- Watering of livestock
- Recreation involving contact with the water
- Recreation not involving contact with water
- Industrial supply
- Municipal or domestic supply or both
- Propagation of wildlife
- Propagation of aquatic life (specifically rainbow trout and brown trout)

Both narrative and numeric criteria are included in Nevada's water quality standards. The narrative standards are applicable to all surface waters of the state and consist mostly of statements requiring waters to be "free from" various pollutants including those that are toxic. The numeric standards for conventional pollutants are broken down into two types: class and water body specific. For the class waters, criteria for various pollutants are established to protect the beneficial uses of classes of water, from A to D; with Class A designated as the highest water quality. The water bodies or reaches belonging to these classes are specifically named in the regulations.

For major water bodies in Nevada, site-specific numeric standards have been developed. These standards include both criteria designed to protect the beneficial uses and antidegradation requirements. The antidegradation is addressed through the establishment of "requirements to maintain existing higher quality" or RMHQs. RMHQs are set when existing water quality (as evidenced by the monitoring data) for individual parameters is higher than the criteria necessary to protect the beneficial uses. This system of directly linking antidegradation to water quality standards provides a manageable means for implementing antidegradation through the permit program and other programs.

Numeric standards for Bryant Creek can be found in NAC 445A.144 *"Standards for Toxic Materials Applicable to Designated Waters"* and 445A.148, *"Carson River: Bryant Creek Near the State Line"*. The numeric standards for the toxics arsenic, copper, iron and nickel are summarized in Table 1 and include concentrations associated with both the "dissolved" and "total" components, if applicable, and the designated beneficial use. Numeric standards for total suspended solids, turbidity and temperature are summarized in Table 2.

Numerical standards for arsenic have been set based on total arsenic and dissolved arsenic (III) concentrations. For total arsenic, the most restrictive standard is for the protection of municipal or domestic water supply. For dissolved arsenic (III), the most restrictive standard is for the protection of aquatic life.

In the guidance document entitled *"National Recommended Water Quality Criteria-Correction" (EPA 822-Z-99-001)*, EPA suggests using the arsenic (III) standard for total dissolved arsenic. EPA implies that arsenic (III) and arsenic (V) are equally toxic to aquatic life and their toxicities are additive. In addition, EPA has recommended that the existing Arsenic (III) 1-hour Aquatic Life water quality criteria be decreased from 342 to 340 µg/l and the 96-hour Aquatic Life criteria be decreased from 180 to 150 µg/l.

Table 1. Arsenic, Copper, Iron and Nickel Standards[1]

Parameter	Dissolved or Total	Beneficial Use	Numeric Standard (µg/l)[2,3]	Comments
Arsenic	Dissolved	Aquatic Life 1-hour average	342	
		Aquatic Life 96-hour average	180	
	Total	Municipal or Domestic Supply	50	
		Irrigation	100	
		Watering of Livestock	200	
Copper	Dissolved	Aquatic Life 1-hour average	$0.85*e^{(0.9422*\ln(H)-1.464)}$	If Hardness = 50 mg/l, Standard = 8 µg/l If Hardness = 200 mg/l, Standard =29 µg/l
		Aquatic Life 96-hour average	$0.85*e^{(0.8545*\ln(H)-1.465)}$	If Hardness = 50 mg/l, Standard =6 µg/l If Hardness = 200 mg/l, Standard =18 µg/l
	Total	Irrigation	200	
		Watering of Livestock	500	
Iron	Total	Aquatic Life	1,000	
		Irrigation	5,000	
Nickel	Dissolved	Aquatic Life 1-hour average	$0.85*e^{(0.8460*\ln(H)+3.3612)}$	If Hardness = 50 mg/l, standard = 671 µg/l If Hardness = 200 mg/l, standard = 2167 µg/l
		Aquatic Life 96-hour average	$0.85*e^{(0.8460*\ln(H)+1.1645)}$	If Hardness = 50 mg/l, standard = 75 µg/l If Hardness = 200 mg/l, standard = 241 µg/l
	Total	Municipal or Domestic Supply	13.4	
		Irrigation	200	

[1]*Source: NAC 445A.144*
[2]*e = 2.718*

Copper and nickel, standards have been set for both dissolved and total concentrations. It is important to note that the dissolved constituent standards are for the protection of aquatic life, and that these standards are dependent on water hardness, expressed as mg/l $CaCO_3$.

The total suspended solids standard (TSS) of 25 µg/l and turbidity standard of 10 NTU has been established to protect aquatic life. Both TSS and turbidity standards apply year-round. The temperature standard has been established to ensure that aquatic life and water contact recreation use is maintained. As shown in Table 2, the temperature standard is seasonal, for the protection of various life stages of fish.

Table 2. Total Suspended Solids, Turbidity and Temperature Standards

Parameter	Beneficial Use	Numeric Standard (^{o}C, µg/l or NTU)	Comments
Turbidity	Aquatic Life	≤ 10 NTU	
Total Suspended Solids	Aquatic Life	≤ 25 µg/l	
Temperature	Aquatic Life	≤ 13^{o}C	November - May
		≤ 17^{o}C	June
		≤ 21^{o}C	July
		≤ 22^{o}C	August - October

Source: NAC 445A.148.

2.3 303(d) Listing

Section 303(d) of the Clean Water Act requires each state develop a list of water bodies that need additional work beyond existing controls to achieve or maintain water quality standards, and submit an updated list to the Environmental Protection Agency (EPA) every two years. The Section 303(d) List provides a comprehensive inventory of water bodies impaired by all sources.

For the 2002 listing, a water body was generally included if adequate data existed to document exceedence of the beneficial use standards more than 10 percent of the time during the 1997 through 2001 monitoring period. In most cases these determinations have been made based upon data collected as part of NDEP's statewide ambient monitoring network.

Bryant Creek first appeared on 303(d) lists in 1998 for copper, iron and nickel. The decision to include the creek on the 1998 List was based upon data and information collected by NDEP-BWQP, EPA and other agencies. As additional data was collected and evaluated, the 2002 303(d) List was expanded to include arsenic, turbidity, total suspended solids and temperature.
The justification for adding temperature to the 303(d) impaired waters listing, warrants further explanation. During the 1997 through 2001 monitoring period, only 24 quarterly field temperature measurements were taken and recorded by NDEP-BWQP. Furthermore, during this

period, three exceedences of the seasonal temperature standard were observed. After applying 303(d) listing criteria, it was concluded that Bryant Creek did not appear to be impaired for temperature. However, NDEP-BWQP believes that exceedence of the temperature standard occurs more frequently than the data shows, particularly during periods of low flow. As a result, NDEP-BWQP is of the opinion that temperature impairment is a potential problem that needs to be addressed. This is discussed further in Section 3.6 Temperature.

2.4 Water Quantity and Quality

2.4.1 Primary Monitoring Stations

Locations of the water quantity and water quality monitoring stations for the Bryant Creek basin are listed in Table 3 and listed in Figure 2. Data collected at these stations were the primary source of water quantity and water quality information utilized in the development of the TMDL. Detailed water data is presented in Appendix A.

Table 3. List of Selected Water Quantity and Water Quality Monitoring Stations

USGS/ STORET ID	Description	Agency	Period of Record	Pertinent Data Available
Stream flow Gauging Stations				
10308800	Bryant Creek near Gardnerville, NV	USGS	1961-69, 1977-80, 1994-Present	Stream flow
Water Quality Monitoring Stations				
310592	Bryant Creek at Doud Springs	Nevada	1997-Present	Dissolved and Total Arsenic, Dissolved and Total Copper, Dissolved and Total Iron, Temperature, Turbidity and Total Suspended Solids
310009	Bryant Creek above Confluence with East Fork Carson River	Nevada	1977-1991 (various years)	Total Copper, Total Iron
STATION25	Bryant Creek below Confluence with Mountaineer Creek	California	1984- Present	Dissolved and Total Arsenic, Dissolved and Total Copper, Dissolved and Total Iron, Dissolved and Total Nickel and Stream flow
G8307000	Bryant Creek near Gardnerville, NV	California	May 8, 1969	Dissolved Copper, Total Iron
G8307449	Bryant Creek at Bridge below Leviathan Creek	California	May 8, 1969	Dissolved Copper, Total Iron
G8306510	Bryant Creek at Mouth	California	May 8, 1969	Dissolved Copper, Total Iron

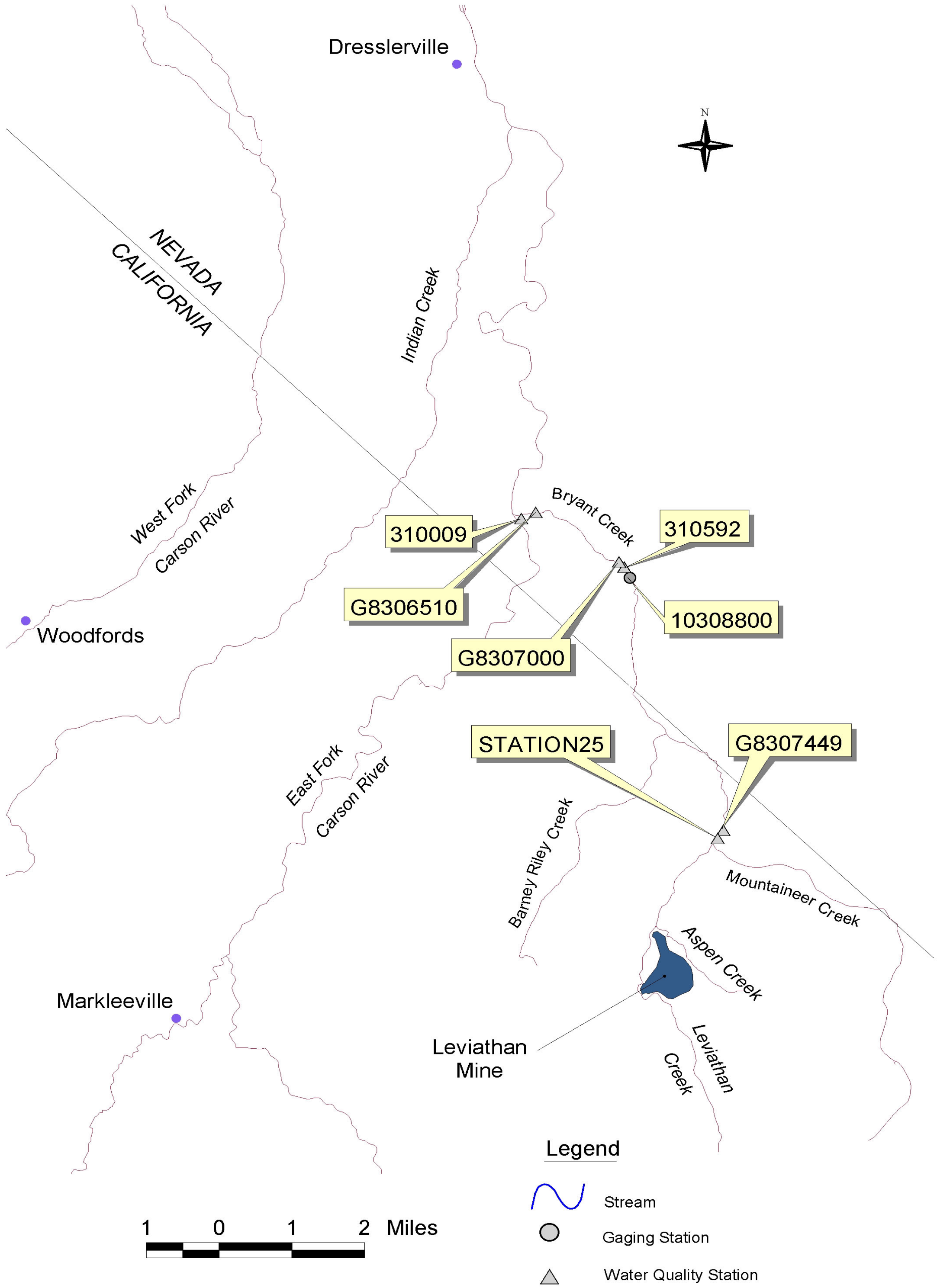
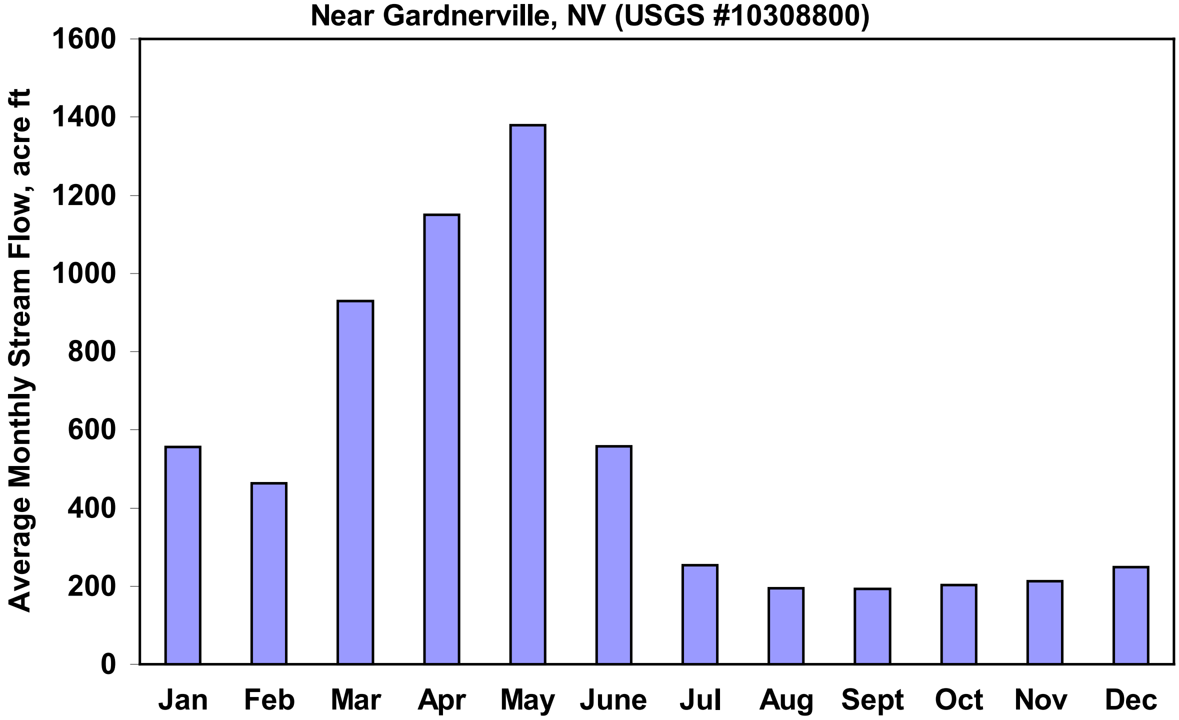


Figure 2. Selected Water Quantity and Quality Monitoring Stations

2.4.2 Water Quantity

Surface water in Bryant Creek is comprised primarily of direct runoff from rainfall and snowmelt with the highest flows typically occurring in March through May as shown in Figure 3. Bryant Creek drains a relatively small watershed with a total area of 31.5 square miles. On the average, Bryant Creek discharges about 7,000 acre-feet per year into the East Fork Carson River. Creek flows account for about 2 percent of the flow in the East Fork Carson River at this point.

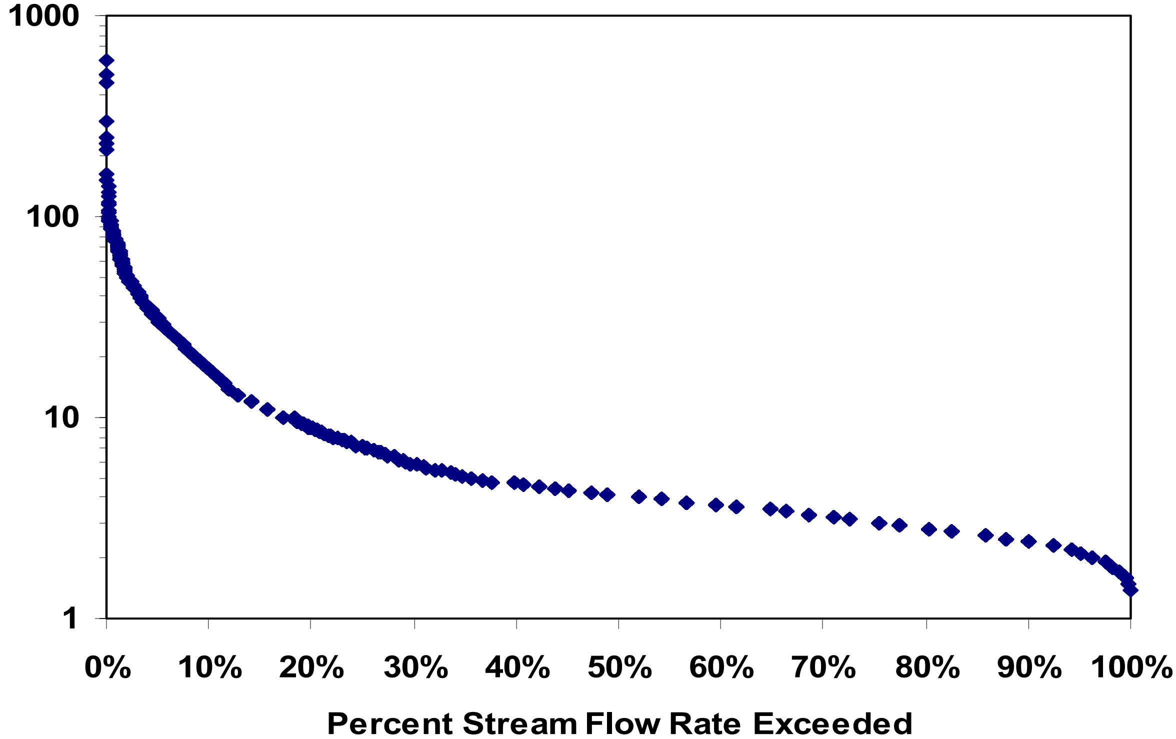
Figure 3. Average Monthly Stream Flow (1961-2001)--Bryant Creek Near Gardnerville, NV (USGS #10308800)



The flow duration curve presented in Figure 4, is based on a percentage of the ranking of the Bryant Creek average daily stream flow rates between years 1961 and 2001, almost 7000 daily events. The plot demonstrates the frequency (or likelihood) of a particular stream flow rate occurring. The curve in Figure 4 was developed from data collected at USGS flow gauge #10308800, located below Doud Springs near Gardnerville, NV. During this period, Daily stream flow rates ranged from a low of 1.4 cu ft/sec to a high of 600 cu ft/sec with an average stream flow rate of 8.63 cu ft/sec.

From the flow duration curve presented in Figure 4, approximately 99.5% of the daily flow rate data was less than or equal to 90 cu ft/sec. Approximately 95% of the daily stream flow rates were 32 cu ft/sec or less. Approximately 90 % of the daily stream flow rates were less than 18 cu ft/sec for the same 40-year period. At USGS flow gauge #10308800, the 40-year daily average stream flow rate of 8.63 cu ft/sec, was exceeded approximately 20% of the time.

Figure 4. Flow Duration Curve for Bryant Creek at USGS #10308800, 1961 - 2001



2.4.3 Water Quality

For over 50 years, acid mine drainage exiting the Leviathan Mine site has directly impacted Leviathan Creek and Aspen Creek water quality and subsequently the water quality of Bryant Creek. As discussed earlier, Bryant Creek first appeared on 303(d) lists in 1998 for copper, iron and nickel. The decision to include Bryant Creek on the 1998 List was based upon data and information collected by NDEP-BWQP, EPA and other agencies. As additional data was collected and evaluated, the 2002 Bryant Creek 303(d) Listing was expanded to include arsenic, turbidity, total suspended solids and temperature. Existing water quality is discussed in greater detail in ***Section 3.0 Total Maximum Daily Loads (TMDL).***

3.0 Total Maximum Daily Loads (TMDL)

3.1 Arsenic

3.1.1 Problem Statement

Impoundment pond overflow and drainage from the Leviathan Mine site have long been recognized as the primary source of arsenic impairment to Bryant Creek. Unfortunately, accurate characterization of creek loadings cannot be determined due to the nature of the loads and the lack of available monitoring data. Arsenic loadings would be expected to increase with increasing flow, but because of the sporadic nature of these loads, it is difficult to estimate average annual loads. For this reason, no attempt was made to further quantify historic arsenic loads to Bryant Creek.

Table 4, Figure 5 and Figure 6 summarize total recoverable and total dissolved (filtered) arsenic data as collected by NDEP-BWQP since 1997 and CRWQCB at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984.

Table 4. Summary of Arsenic Water Quality Standards and Historic Data (µg/l)

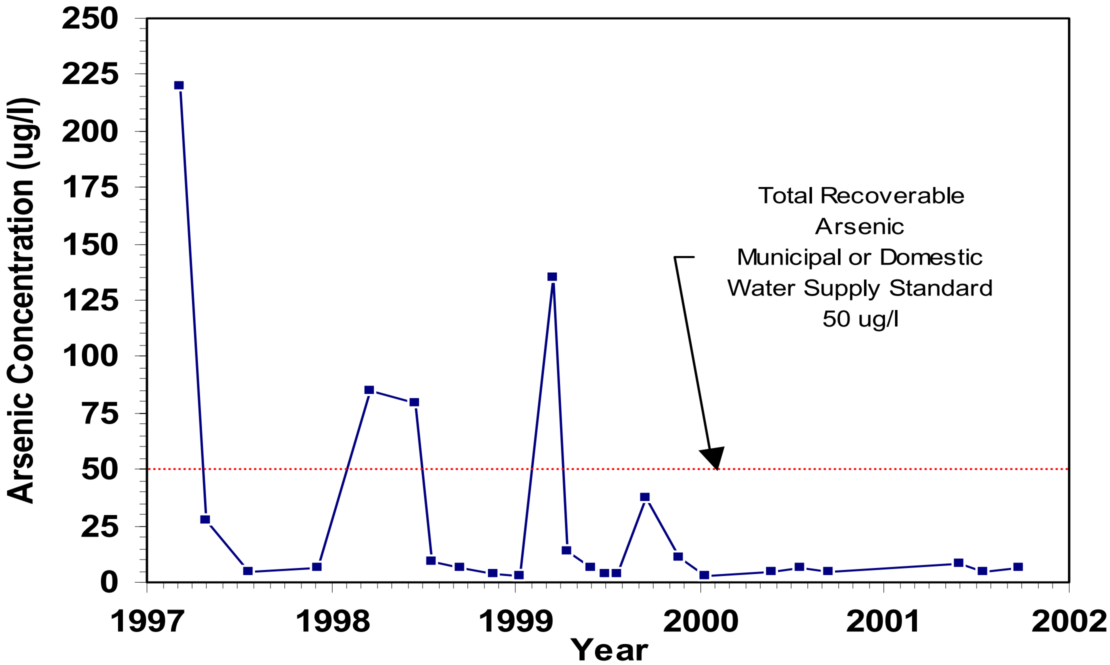
Parameter	Bryant Creek at Doud Springs (310592)			Bryant Creek below confluence of Mountaineer Creek (Station 25)		
	Dissolved		Total	Dissolved		Total
Most restrictive beneficial use	Aquatic Life		Municipal or Domestic Water Supply	Aquatic Life		Municipal or Domestic Water Supply
	1-hr	96-hr		1-hr	96-hr	
Standard *(NAC 445A.144)*	342 µg/l	180 µg/l	50 µg/l	342 µg/l	180 µg/l	50 µg/l
Period of Record	1997-2001		1997-2001	1994-2001		1984-2001
No. of Samples	17		24	92		65
% Exceeding Standard	0%	0%	17%	0%	1%	17%
Average	4.35		28.88	12.87		58.92
Median	4.0		6.0	5.0		7.8
Minimum	1.0		3.0	0.5		1.5
Maximum	8.0		220	180		1500

An evaluation of NDEP-BWQP data collected shows that exceedences of the total recoverable arsenic standard occurred about 17 percent of the time during the 1997-2001 period of record. During this same period, dissolved arsenic concentrations were less than 1-hr and 96-hr aquatic life beneficial use standard (BUS).

High arsenic levels occurred during spring runoff periods, often the result of overflow from evaporation ponds at the Leviathan Mine site. Prior to the 2000 runoff season, additional evaporation pond capacity was made available, preventing pond overflows during the spring of

2000 (U.S. EPA, November 1999). Figure 5 shows that total recoverable arsenic concentrations have remained below the 50µg/l BUS since April 1999.

Figure 5. Total Recoverable Arsenic Concentrations - Bryant Creek at Doud Springs (NDEP/STORET 310592)



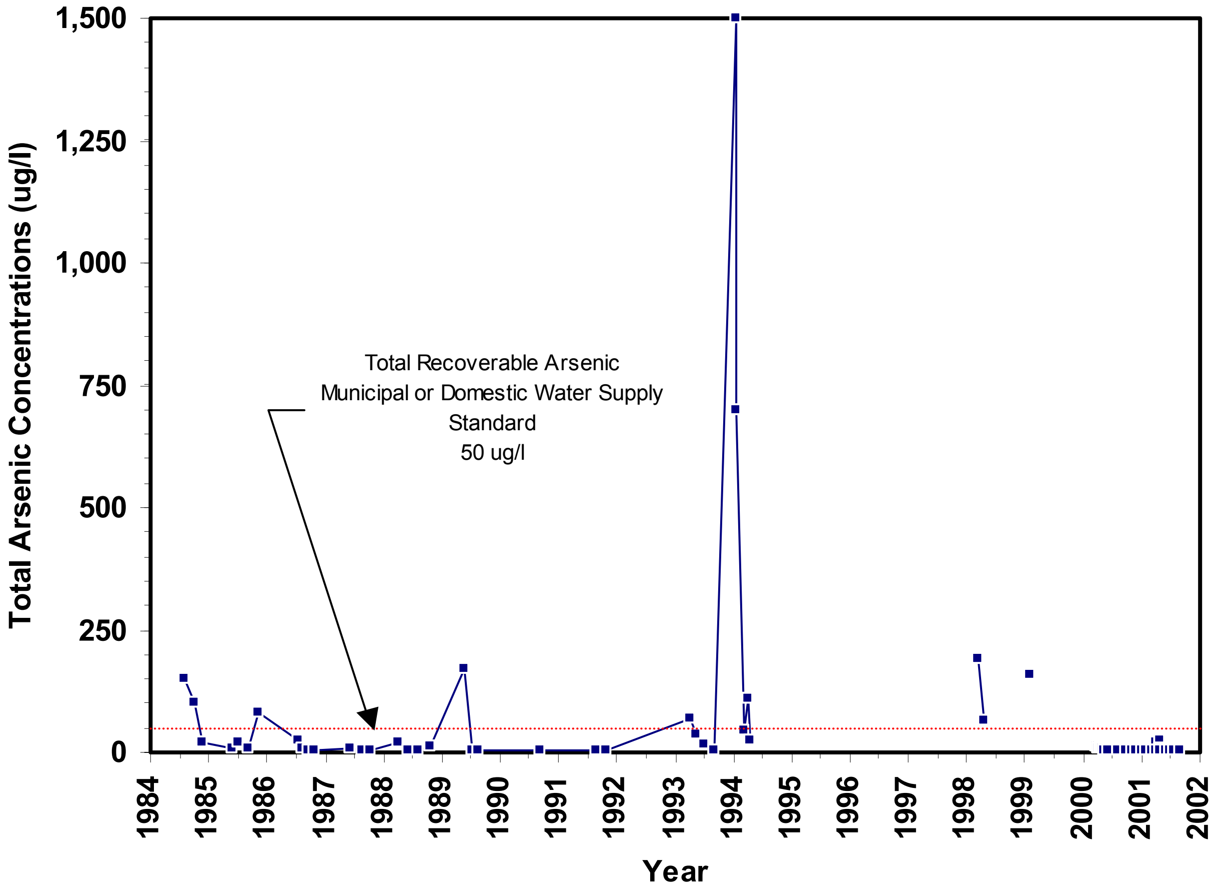
An attempt was made to correlate stream flow data from the USGS-Doud Springs monitoring site with the total recoverable arsenic concentrations. It was concluded that a poor correlation existed between stream flow and arsenic.

Although CRWQCB Monitoring Station 25 is located in California, it serves as a convenient reference and data collection point. Data from the site was used to further quantify arsenic impairment of Bryant Creek, and identify any trends. Of particular interest was the effect of increased evaporation pond capacity, constructed prior to the 2000 runoff season, and its impact on arsenic impairment.

Unfortunately, data is sporadic from September 1994 through March 2000, the period where arsenic exceedences occurred frequently. However, based on available CRWQCB monitoring data, NDEP-BWQP has determined that the total recoverable arsenic BUS was still exceeded 17 percent of the time during the 1984 – 2001 period of record. The total recoverable arsenic concentrations and exceedences of the BUS are plotted in Figure 6. For the same period, only one exceedence of the NAC 96-hr total dissolved arsenic BUS was observed, which equates to an exceedence of 1 % of the time.

Although the quantity of data is limited between 1994 and 2000, the construction of additional evaporation pond capacity appears to have reduced the frequency of exceedence of the total recoverable arsenic beneficial use standard. From Figure 6, it can be seen that no total arsenic BUS exceedences have been observed since construction.

Figure 6. Total Recoverable Arsenic Concentrations - Bryant Creek below Confluence with Mountaineer Creek (CRWQCB STATION 25)



3.1.2 *Target Analysis*

Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards. According to the U.S. EPA (1999), one of the primary goals of target analyses are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

As discussed earlier, NAC 445A provides numeric criteria for total recoverable arsenic concentrations in Bryant Creek. This standard has been set at a certain level as needed to ensure continued support of the designated beneficial uses. The ultimate goal of this Bryant Creek TMDL is to support this use through compliance with the numeric standard shown in Table 5.

Table 5. Total Recoverable Arsenic Target Concentrations/Levels for Bryant Creek

Parameter	Most Restrictive Beneficial Use	Numeric Target	Comments
Total Recoverable Arsenic	Municipal or Domestic Water Supply	50 μg/l	Source: NAC 445A.144

3.1.3 Pollutant Load Capacity and Allocation

In development of a TMDL, allowable allocations needed to meet water quality standards are to be defined for the various sources. Total load allocation is defined as the sum of waste load allocations to point sources, non point and natural background sources. A margin of safety is included in the analysis, with consideration given to seasonal variations and critical conditions.

The goal of a TMDL is to allocate pollutant loads, determine the necessary load reductions and (through its implementation plan) define a set of actions such that the load reductions will be achieved and water quality standards will be met. With no identifiable sources in Nevada, the water quality standard for arsenic is only achievable through actions taken in California. Therefore only gross (point, non point and natural source allocations combined) load allocations have been set for the Nevada-California state line (as measured at USGS gauging station No. 10308800).

Allocations for arsenic are summarized in Table 6. The "Average Allowable Load" values were calculated using the following equation:

Avg. Allowable Load (lbs/day) = Target concentration (μg/l) x Avg. Daily Flow (cfs) x 0.005394

A margin of safety and seasonal variations were considered in the allocation process as discussed below. Gross load allocations include a margin of safety (MOS) needed to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. The gross load allocations in this report incorporate an explicit MOS of 10% to account for uncertainty in the long-term average annual flow values from the gauged data at Station 10308800. The Gross Load Allocation equation is as follows:

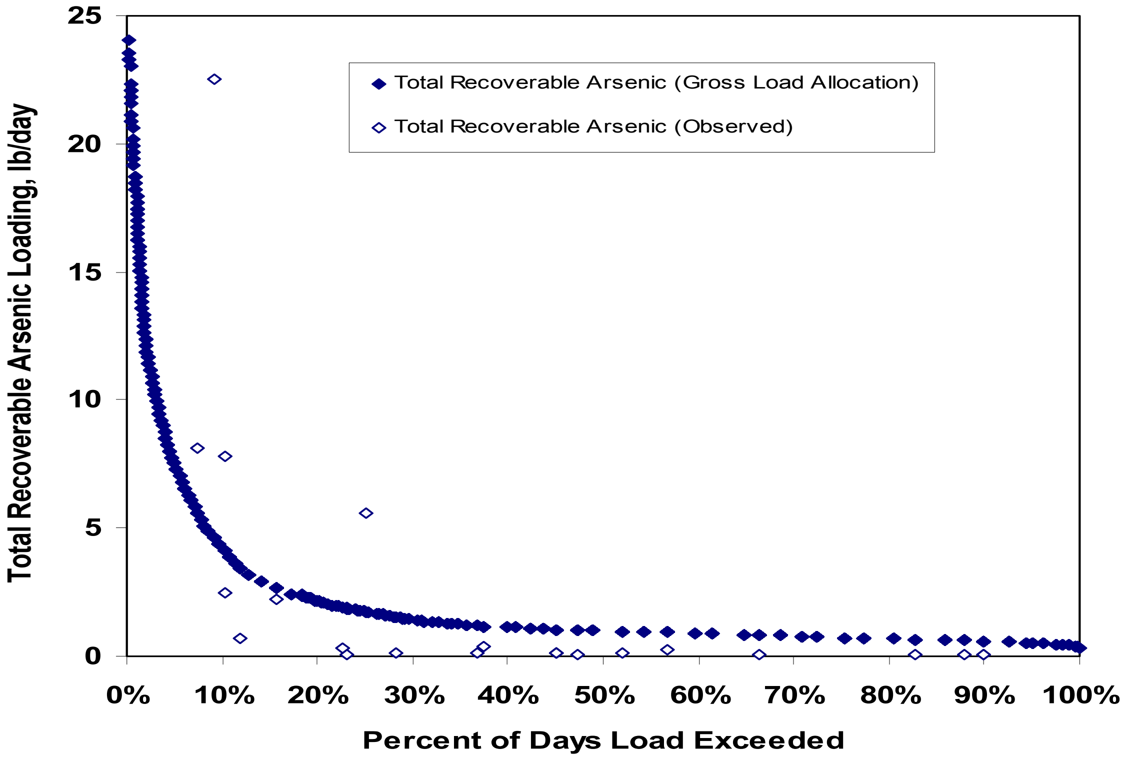
Gross Load Allocation (lbs/day) = Average Allowable Load (lbs/day) x 0.90

Table 6. Bryant Creek Total Recoverable Arsenic Load Allocations

Parameter	Target Concentration/Level and Most Restrictive Use	Average Daily Stream flow, cubic feet per second	Average Allowable Load, pounds per day	Gross Load Allocation, pounds per day (with 10% MOS)
Total Recoverable Arsenic	50.0 μg/l Municipal/Domestic Water Supply	8.63	2.33	2.10

The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This can be readily accomplished through the use of load duration curves presented in Figure 7.

Figure 7. Total Recoverable Arsenic Loading for Bryant Creek at California-Nevada Stateline



The gross load allocation duration curves are generated by applying target concentrations to the daily stream flow data, along with a margin of safety, to calculate allowable daily loads; and represent the gross load allocations over the historic flow range. Because most sites in Nevada lack sufficient monitoring data, the ability to determine actual historic loads and load reductions is limited at this time. However, by plotting known historic "grab" sample data against the load duration curves, one can better understand the conditions under which the load allocations are exceeded.

For Bryant Creek, target concentrations for total recoverable arsenic obtained from Table 6, were applied to daily stream flow data obtained from USGS flow gauge #10308800. A 10% margin of safety was utilized to calculate gross allowable daily loading for total dissolved and total recoverable copper. Actual grab sample data for copper, collected by NDEP-BWQP (STORET #310592) between March 1997 and November 2001 was plotted against the load duration curve.

From Figure 7, observed total recoverable arsenic loadings exceeded the target loadings during periods of high flow. These four high flow events were the result of impoundment pond overflows, which occurred in 1997, 1998 and 1999. Since 1999, impoundment pond storage capacity has been increased significantly, reducing the likelihood of further overflows into Bryant Creek.

3.1.4 Future Needs

As stated earlier in Section 1.3, the Bryant Creek TMDL represents a "phased" approach to the adoption and implementation of the TMDL for total recoverable arsenic. Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information, provide estimates of existing loads and load reductions, identify natural arsenic sources, and if necessary, revise the TMDL. In addition, as more data is collected, NDEP-BWQP will determine if the removal of total recoverable arsenic from the 303(d) List for future listing cycles is justified.

Note that attainment of water quality standards is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to achieve compliance with the total recoverable arsenic water quality standards and the TMDL.

3.2 Copper

3.2.4 Problem Statement

Impoundment pond overflow and drainage from the Leviathan Mine site have long been recognized as the primary source of copper impairment to Bryant Creek. Unfortunately, accurate characterization of creek loadings cannot be determined due to the nature of the loads and the lack of available monitoring data. Copper loadings would be expected to increase with increasing flow, but because of the sporadic nature of these loads, it is difficult to estimate average annual loads. For this reason, no attempt was made to further quantify historic copper loads to Bryant Creek.

Table 7 and Figure 8 summarize copper data collected by NDEP-BWQP (Bryant Creek at Doud Springs) since 1997 and CRWQCB at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984.

Table 7. Summary of Water Quality Standards and Historical Copper Data (µg/l)

Parameter	Bryant Creek at Doud Springs (310592)			Bryant Creek below confluence of Mountaineer Creek (Station 25)		
	Total Dissolved		Total Recoverable	Total Dissolved		Total Recoverable
Most restrictive beneficial use	Aquatic life 1-hr	Aquatic life 96-hr	Irrigation	Aquatic life 1-hr	Aquatic life 96-hr	Irrigation
Standard *(NAC 445A.144)*	Varies with hardness		200 µg/l	Varies with hardness		200 µg/l
Period of Record	1997-2001		1997-2001	1994-2001		1994-2001
No. of Samples	18		25	52	52	31
% Exceeding Standard	0%	0%	0%	12%	15%	0%
Average	7.1		18.6	19.79		20.71
Median	10		10	2.50		6.8
Minimum	0		0	1.25		5.0
Maximum	10		110	500		110

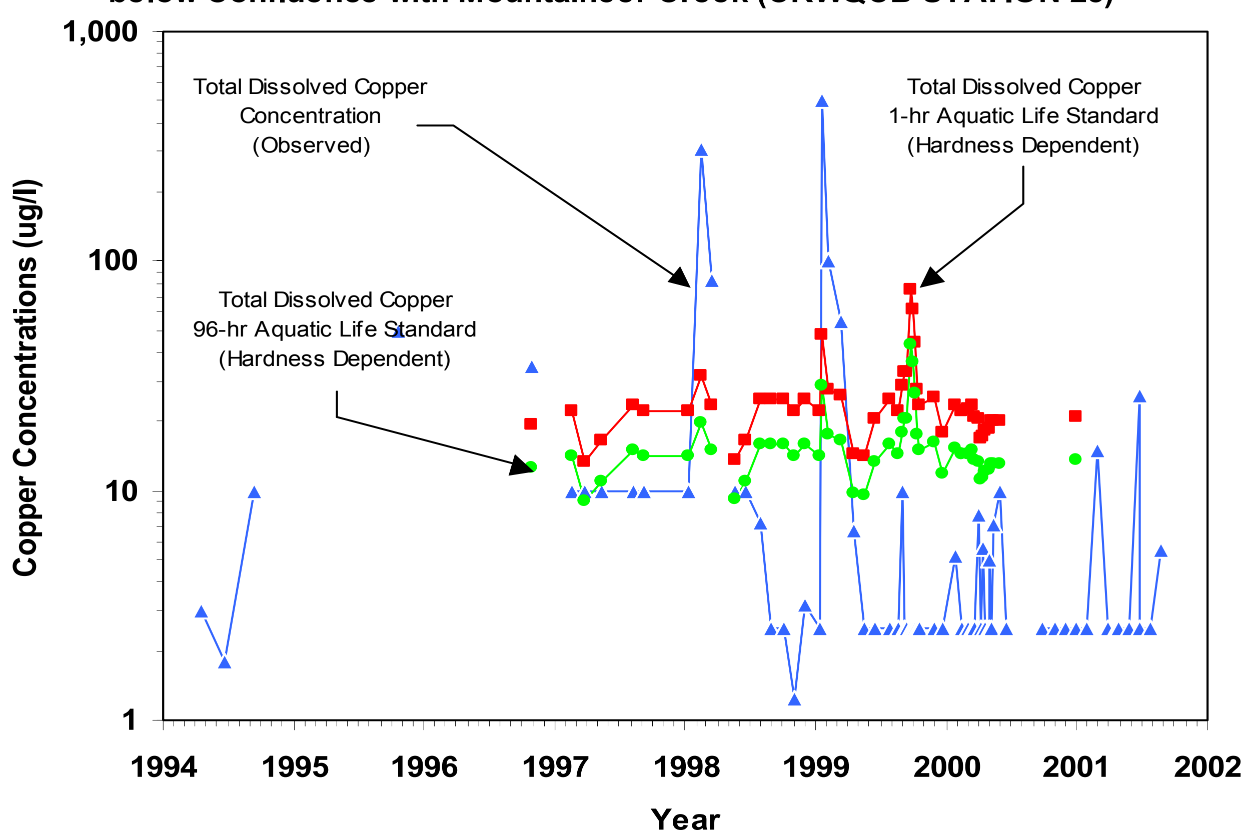
Differences between Nevada and California laboratory detection limits (MDL) have a pronounced effect on the demonstration of compliance with the beneficial use standards (BUS). The Nevada State Laboratory is contracted by NDEP-BWQP to perform sample analyses for the agency. For copper, the laboratory's MDL is 20 ug/l. CRWQCB water quality analyses are performed in independent analytical laboratories with a lower MDL of 2.50 ug/l. As is the case of most analytical laboratories, analyses reported as "less than MDL" are considered to be estimates.

Table 7 shows that during the 1997 through 2001 monitoring period, the total recoverable copper BUS of 200 ug/l was never exceeded for Bryant Creek at Doud Springs. However, for dissolved copper, is unclear whether or not the 1-hr aquatic life and 96-hr aquatic life BUS are being exceeded at any given time. All of the dissolved copper analyses reported to NDEP-BWQP, were at or below the detection limit, which is above the total dissolved copper standard. Note that the total dissolved copper standard varies with hardness, making any BUS compliance determination difficult at best. Because of the uncertainties in the laboratory analyses, NDEP-BWQP has concluded that, any compliance with the BUS at this location based on this data is not possible.

Although CRWQCB Monitoring Station 25 is located in California, it serves as a convenient reference and data collection point. Data from the site was used to further quantify copper impairment of Bryant Creek, and identify any trends. Of particular interest was the effect of increased evaporation pond capacity, constructed prior to the 2000 runoff season, and its impact on copper impairment in Bryant Creek.

As indicated in Table 7, CRWQCB data shows no exceedences of the 200-ug/l total recoverable copper BUS during the 1994 – 2001 monitoring period. However, for dissolved copper, exceedence of the 1-hr aquatic life standard occurred 12 percent of the time and the 96-hr aquatic life BUS was exceeded 15 percent of the time during the 1994 – 2001 monitoring period. As stated earlier, both the 1-hr and 96-hr aquatic life standards are dependent on hardness, however hardness data after July 1, 2000 is sporadic. As a result, determination of compliance with the dissolved copper BUS in some instances is not possible. This is further demonstrated below in Figure 9.

Figure 8. Total Dissolved Copper Concentrations - Bryant Creek below Confluence with Mountaineer Creek (CRWQCB STATION 25)



As stated earlier, high metal concentrations occur regularly during spring runoff periods and are often the result of evaporation pond overflow at the Leviathan Mine site. Prior to the 2000 runoff season, evaporation pond capacity was expanded. This expansion prevented pond overflows during the spring of 2000, and lowered copper concentrations downstream. This can be readily seen in Figure 8.

An attempt was made to correlate stream flow data from the USGS-Doud Springs monitoring site with the total recoverable and total dissolved copper concentrations. It was concluded that a poor correlation existed between stream flow and both forms of copper.

3.2.2 Target Analysis

Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards. According to the U.S. EPA (1999), one of the primary goals of target analysis are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

As discussed earlier, NAC 445A provides numeric criteria for total dissolved copper in Bryant Creek. These standards have been set at certain levels as needed to ensure continued support of the designated beneficial uses. The ultimate goal of this Bryant Creek TMDL is to support these uses through compliance with the numeric standards as shown in Table 8.

Table 8. Total Dissolved Copper Target Concentrations/Levels for Bryant Creek at California-Nevada Stateline

Parameter		Most Restrictive Beneficial Use	Numeric Target	Comments
Copper	Total Dissolved	Aquatic Life 1-hr	**Variable: Between 14.07 and 26.08 µg/l**	Based upon a measured hardness between 93 and 179 mg/l (as $CaCO_3$). Hardness data falls within this range 90% of the time.
		Aquatic Life 96-hr	**Variable: Between 9.42 and 16.50 µg/l**	

Source: NAC 445A.144.

Dissolved copper concentration is dependent on hardness, expressed as mg/l $CaCO_3$. For the purpose of the Bryant Creek TMDL, 90% of the hardness data collected by NDEP-BWQP falls between 93 and 179 mg/l. As a result, total dissolved copper load allocations are presented in Table 8 as a range of values rather than a single value. Note that for dissolved copper, two targets are listed in Table 8, however the most restrictive 96-hr Aquatic Life Beneficial Use Standard was selected as the basis for the target concentration in Table 9.

3.2.3 Pollutant Load Capacity and Allocation

In development of a TMDL, allowable allocations needed to meet water quality standards are to be defined for the various sources. Total load allocation is defined as the sum of waste load allocations to point sources, nonpoint and natural background sources. A margin of safety is included in the analysis, with consideration given to seasonal variations and critical conditions.

The goal of a TMDL is to allocate pollutant loads, determine the necessary load reductions and (through its implementation plan) define a set of actions such that the load reductions will be achieved and water quality standards will be met. With no identifiable sources in Nevada, the water quality standards for copper are only achievable through actions taken in California. Therefore only gross (point, non point and natural source allocations combined) load allocations have been set for the Nevada-California state line (as measured at USGS gauging station No. 10308800).

Allocations for dissolved copper are summarized in Table 9. The "Average Allowable Load" values were calculated using the following equation:

Avg. Allowable Load (lbs/day) = Target concentration (μg/l) x Avg. Daily Flow (cfs) x 0.005394

A margin of safety and seasonal variations were considered in the allocation process as discussed below. Gross load allocations include a margin of safety (MOS) needed to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. The gross load allocations in this report incorporate an explicit MOS of 10% to account for uncertainty in the long-term average annual flow values from the gauged data at Station 10308800. The Gross Load Allocation equation is as follows:

Gross Load Allocation (lbs/day) = Average Allowable Load (lbs/day) x 0.90

Table 9. Bryant Creek Total Dissolved Copper Load Allocations at California-Nevada Stateline

Parameter		Target Concentration/Level and Most Restrictive Use	Average Daily Stream flow, cubic feet per second	Average Allowable Load, pounds per day	Gross Load Allocation, pounds per day
Total Dissolved Copper	**Aquatic Life 96-hr**	Variable: Between 9.42 and 16.50 μg/l	8.63	Between 0.44 and 0.77	Between 0.40 and 1.09

The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. For most pollutants, load duration curves are useful tools for determining allowable and target loads over the entire flow range. However, for some pollutants (i.e. dissolved copper), the load duration curve approach does not work well. These pollutants have standards that vary according to hardness.

3.2.4 Future Needs

As stated earlier in Section 1.3, the Bryant Creek TMDL represents a "phased" approach to the adoption and implementation of the TMDL for total dissolved copper. Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information, provide estimates of existing loads and load reductions, identify natural copper sources and if necessary, revise the TMDL. In addition, as more data is collected, NDEP-BWQPwill determine if the removal of total dissolved copper from the 303(d) List for future listing cycles is justified.

Note that attainment of water quality standards for Bryant Creek is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to achieve compliance with the total dissolved copper water quality standards and the TMDL.

An issue that will need to be addressed is improved copper detection capability for the Nevada State Laboratory (NSL). Currently, the NSL minimum detection limit (MDL) for copper is 20 ug/l. In comparison, CRWQCB's contract laboratories have a significantly lower minimum detection limit (MDL) of 2.5 ug/l.

This high detection limit prohibits NDEP-BWQP from adequately determining compliance with the aquatic life BUS for total dissolved copper, based only on NDEP-BWQP collected samples. As a result, NDEP-BWQP has had to rely on CRWQCB data for compliance demonstration purposes. It is recommended that the Nevada State Laboratory improve their detection capabilities for low copper concentrations.

3.3 Iron

3.3.1 Problem Statement

Impoundment pond overflow and drainage from the Leviathan Mine site have long been recognized as the primary source of iron impairment to Bryant Creek. Unfortunately, accurate characterization of creek loadings cannot be determined due to the nature of the loads and the lack of available monitoring data. Iron loadings would be expected to increase with increasing flow, but because of the sporadic nature of these loads, it is difficult to estimate average annual loads. For this reason, no attempt was made to further quantify historic iron loads to Bryant Creek.

Table 10, Figure 9 and Figure 10 summarize total recoverable iron data as collected by NDEP-BWQP since 1997 and CRWQCB at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984.

Table 10. Summary of Iron Water Quality Standards and Historical Data (µg/l)

Parameter	Bryant Creek at Doud Springs (310592)		Bryant Creek below confluence of Mountaineer Creek (Station 25)	
	Total Recoverable		Total Recoverable	
Most restrictive beneficial use	Irrigation	Aquatic life	Irrigation	Aquatic life
Standard *(NAC 445A.144)*	5000 µg/l	1000 µg/l	5000 µg/l	1000 µg/l
Period of Record	1997-2001		1984-2001	
No. of Samples	23		42	
% Exceeding Standard	22%	57%	62%	83%
Average	3,596		16,300	
Median	2,355		5,100	
Minimum	210		120	
Maximum	18,650		210,000	

NDEP-BWQP data show that exceedences of the total recoverable iron aquatic life standard occurred 57 percent of the time during the period of record CRWQCB data show that exceedences of the total recoverable iron aquatic life standard occurred 83% of the time during the 1994 – 2001 period of record.

As stated earlier, high metal concentrations occur regularly during spring runoff periods and from evaporation pond overflow at the Leviathan site. Prior to the 2000 runoff season, evaporation pond capacity was expanded. This expansion minimized the impact of pond overflows lowered iron concentrations downstream. This can be readily seen in Figures 11 and 12.

Figure 9. Total Recoverable Iron Concentration - Bryant Creek at Doud Springs (NDEP/STORET #310592)

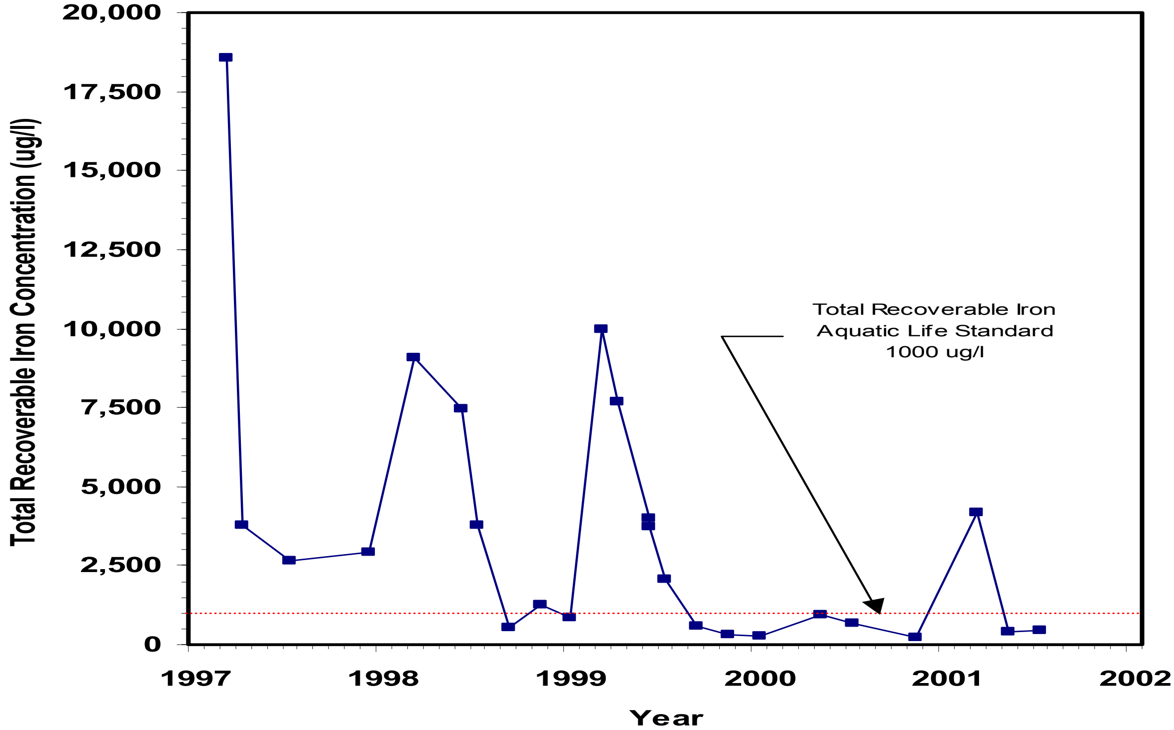
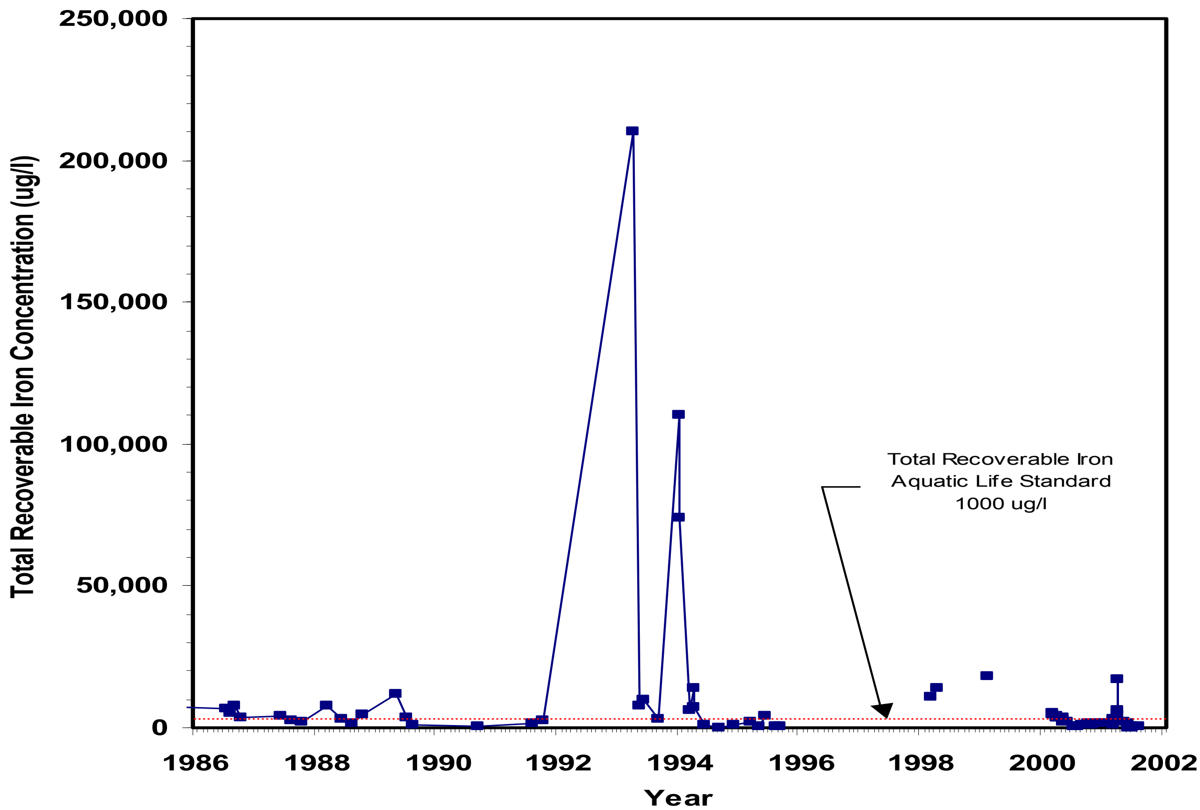


Figure 10. Total Recoverable Iron Concentration - Bryant Creek below Confluence with Mountaineer Creek (CRWQCB STATION 25)



An attempt was made to correlate stream flow data from the USGS-Doud Springs monitoring site with the total recoverable iron concentrations. It was concluded that a poor correlation existed between stream flow and iron concentration.

3.3.2 Target Analysis

Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards. According to the U.S. EPA (1999), one of the primary goals of target analysis are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

As discussed earlier, NAC 445A provides numeric criteria for total recoverable iron in Bryant Creek. These standards have been set at certain levels as needed to ensure support of the designated beneficial uses. The ultimate goal of this Bryant Creek TMDL is to support these uses through compliance with the numeric standards shown in Table 11.

Note that for total recoverable iron, two standards are listed, however the most restrictive Aquatic Life Beneficial Use Standard of 1,000µg/l, was selected as the basis for the target concentration.

Table 11. Iron Target Concentrations/Levels for Bryant Creek

Parameter		Most Restrictive Beneficial Use	Numeric Target	Comments
Iron	Total Recoverable	Aquatic Life	1,000 µg/l	NAC 445A.144

3.3.3 Pollutant Load Capacity and Allocation

In development of a TMDL, allowable allocations needed to meet water quality standards are to be defined for the various sources. Total load allocation is defined as the sum of waste load allocations to point sources, non-point and natural background sources. A margin of safety is included in the analysis, with consideration given to seasonal variations and critical conditions.

The goal of a TMDL is to allocate pollutant loads, determine the necessary load reductions and (through its implementation plan) define a set of actions such that the load reductions will be achieved and water quality standards will be met. With no identifiable sources in Nevada, the water quality standards for iron are only achievable through actions taken in California. Therefore only gross (point, non-point and natural source allocations combined) load allocations have been set for the Nevada-California state line (as measured at USGS gauging station No. 10308800).

Allocations for iron are summarized in Table 12. The "Average Allowable Load" values were calculated using the following equation:

Avg. Allowable Load (lbs/day) = Target concentration (μg/l) x Avg. Daily Flow (cfs) x 0.005394

A margin of safety and seasonal variations were considered in the allocation process as discussed below. Gross load allocations include a margin of safety (MOS) needed to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. The gross load allocations in this report incorporate an explicit MOS of 10% to account for uncertainty in the long-term average annual flow values from the gauged data at Station 10308800. The Gross Load Allocation equation is as follows:

Gross Load Allocation (lbs/day) = Average Allowable Load (lbs/day) x 0.90

Table 12. Bryant Creek Total Recoverable Iron Load Allocations

Parameter		Target Concentration/Level and Most Restrictive Use	Average Daily Stream flow, cubic feet per second	Average Allowable Load, pounds per day	Gross Load Allocation, pounds per day
Iron	Total Recoverable	1,000 μg/l Aquatic Life	8.63	46.55	41.90

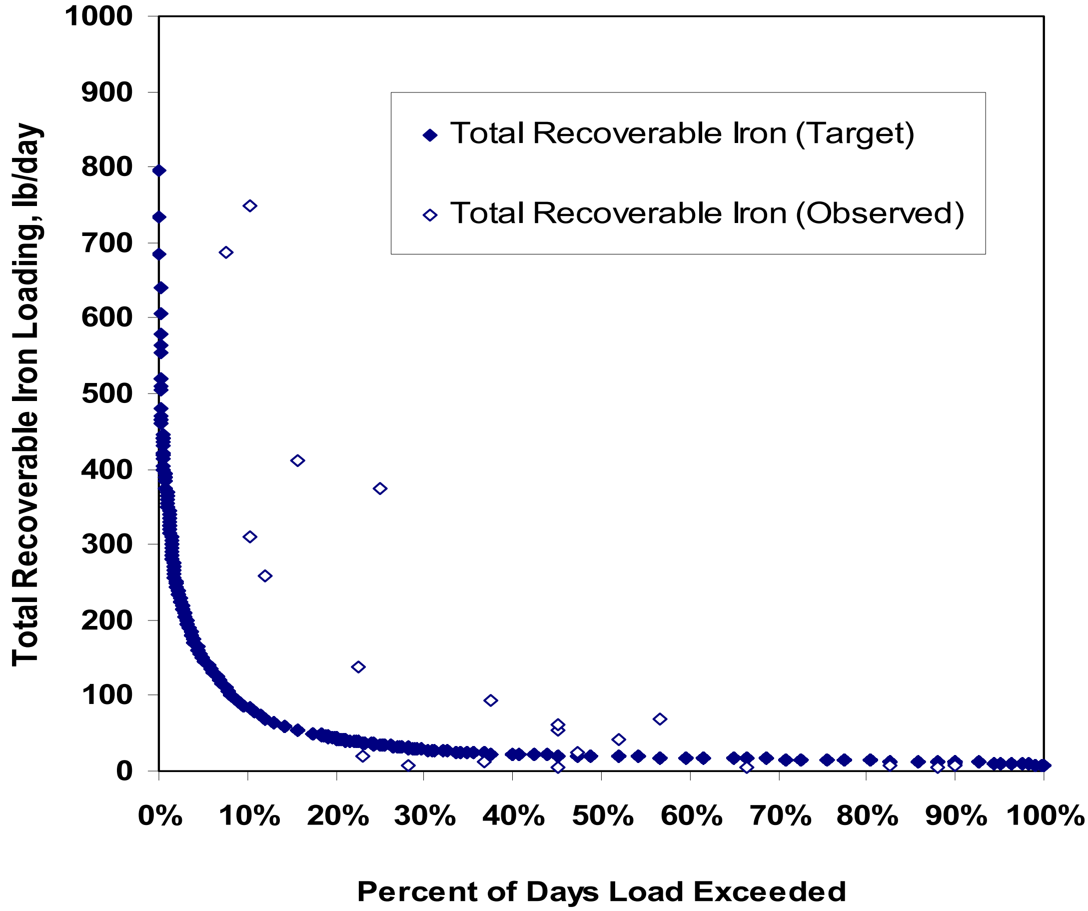
The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This can be readily accomplished through the use of load duration curve presented in Figure 11.

The gross load allocation duration curves are generated by applying target concentrations to the daily stream flow data, along with a margin of safety, to calculate allowable daily loads; and represent the gross load allocations over the historic flow range. Because most sites in Nevada lack sufficient monitoring data, the ability to determine actual historic loads and load reductions is limited at this time. However, by plotting known historic "grab" sample data against the load duration curves, one can better understand the conditions under which the load allocations are exceeded.

For Bryant Creek, target concentrations for total recoverable iron obtained from Table 12, were applied to daily stream flow data obtained from USGS flow gauge #10308800. A 10% margin of safety was utilized to calculate gross allowable daily loading for total recoverable iron. Actual grab sample data for iron, collected by NDEP-BWQP (STORET #310592) between March 1997 and November 2001 was plotted against the load duration curves.

From Figure 11, observed total recoverable iron loadings were above the target loadings for high and intermediate flows. The high iron loadings can be attributed to several decades of stream bank erosion, impoundment pond overflow and natural sources of iron.

Figure 11. Total Recoverable Iron Loading for Bryant Creek at California-Nevada Stateline



3.3.4 Future Needs

As stated earlier in Section 1.3, the Bryant Creek TMDL represents a "phased" approach to the adoption and implementation of the TMDL for total recoverable iron. Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information, provide estimates of existing loads and load reductions, identify natural iron sources and if necessary, revise the TMDL. In addition, as more data is collected, NDEP-BWQP will determine if the removal of total recoverable iron from the 303(d) List for future listing cycles is justified.

Note that the attainment of water quality standards for Bryant Creek is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to maintain compliance with the total recoverable iron water quality standards and the TMDL.

3.4 Nickel

3.4.1 Problem Statement

Impoundment pond overflow and drainage from the Leviathan Mine site have long been recognized as a source of nickel impairment to Bryant Creek. Accurate characterization of creek loadings cannot be determined due to the nature of the loads and the lack of available monitoring data. Nickel loadings would be expected to increase with increasing flow, but because of the sporadic nature of these loads, it is difficult to estimate average annual loads. For this reason, no attempt was made to further quantify historic nickel loads to the Creek.

Table 13 and Figure 12 summarize total recoverable and total dissolved (filtered) nickel data as collected by CRWQCB at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984. Although NDEP-BWQP has been collecting water quality samples from Bryant Creek since 1997, these samples were not analyzed for nickel.

Table 13. Summary of Water Quality Standards and Historical Nickel Data (µg/l)

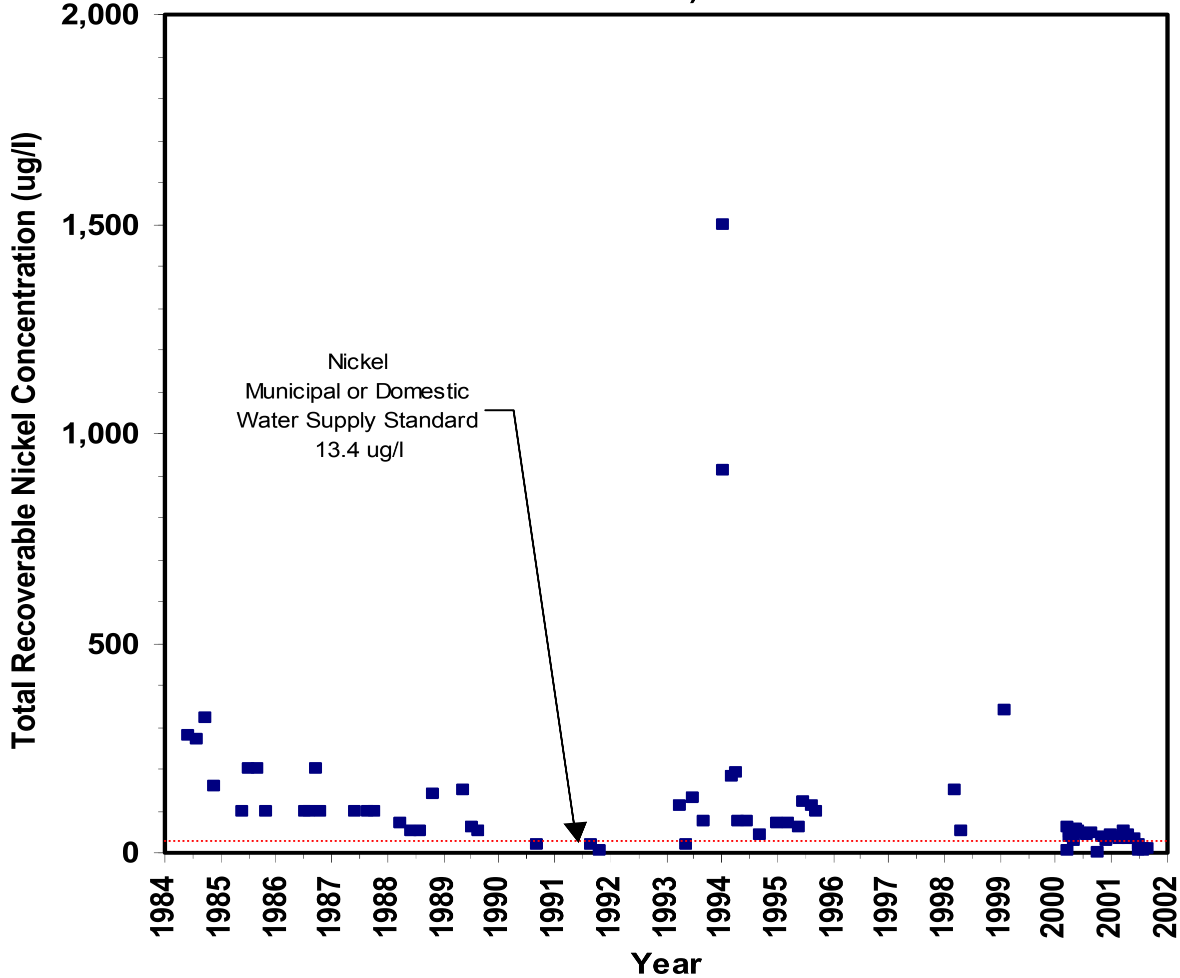
Parameter	Bryant Creek below confluence of Mountaineer Creek (CRWQCB Station 25)			
	Total Recoverable		Total Dissolved	
Most restrictive beneficial use	Municipal or Domestic Water Supply	Irrigation	Aquatic Life 1-hr	Aquatic Life 96-hr
Standard *(NAC 445A.144)*	13.4 µg/l	200 µg/l	Varies with hardness	Varies with hardness
Period of Record	1984-2001			
No. of Samples	76		53	
% Exceeding Standard	91%	8%	0%	4%
Average	111.60		88.30	
Median	56.50		50.00	
Minimum	1.00		1.00	
Maximum	1,500		1,300	

From Table 13, CRWQCB data show that the NAC total recoverable nickel standards for municipal or domestic water supply and irrigation were exceeded 91% and 8 % of the time, respectively, during the 1994 – 2001 period of record. Dissolved nickel concentrations exceeded the 96-hr aquatic life standard, 4 % of the time during the 1994 – 2001 recording period

As stated earlier, high metal concentrations occur regularly during spring runoff periods and evaporation pond overflow at the Leviathan site. Prior to the 2000 runoff season, evaporation pond capacity was expanded. This expansion prevented pond overflows during the spring of 2000, and lower copper concentrations downstream. This can be readily seen in Figure 14.

An attempt was made to correlate stream flow data from the USGS-Doud Springs monitoring site with the total recoverable and total dissolved copper concentrations. It was concluded that a poor correlation existed between stream flow and both forms of nickel.

Figure 12. Total Recoverable Nickel Concentration - Bryant Creek below Confluence with Mountaineer Creek (CRWQCB STATION 25)



3.4.2 Target Analysis

Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards. According to the U.S. EPA (1999), one of the primary goals of target analysis are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

As discussed earlier, NAC 445A provides numeric criteria for total nickel in Bryant Creek. These standards have been set at certain levels as needed to ensure continued support of the designated beneficial uses. The ultimate goal of this Bryant Creek TMDL is to support these uses through compliance with the numeric standards shown in Table 14. Note that for total recoverable nickel, the more restrictive Municipal or Domestic Water Supply standard of 13.4 µg/l was selected as the basis for the target concentration.

Table 14. Nickel Target Concentrations/Levels for Bryant Creek

Parameter	Most Restrictive Beneficial Use	Numeric Target	Comments
Total Recoverable Nickel	Municipal or Domestic Supply	13.4 µg/l	NAC 445A.144

3.4.3 Pollutant Load Capacity and Allocation

In development of a TMDL, allowable allocations needed to meet water quality standards are to be defined for the various sources. Total load allocation is defined as the sum of waste load allocations to point sources, non-point and natural background sources. A margin of safety is included in the analysis, with consideration given to seasonal variations and critical conditions.

The goal of a TMDL is to allocate pollutant loads, determine the necessary load reductions and (through its implementation plan) define a set of actions such that the load reductions will be achieved and water quality standards will be met. With no identifiable sources in Nevada, the water quality standards for nickel are only achievable through actions taken in California. Therefore only gross (point, non-point and natural source allocations combined) load allocations have been set for the Nevada-California state line (as measured at USGS gauging station No. 10308800). Allocations for nickel are summarized in Table 15. The "Average Allowable Load" values were calculated using the following equation:

Avg. Allowable Load (lbs/day) = Target concentration (µg/l) x Avg. Daily Flow (cfs) x 0.005394

A margin of safety and seasonal variations were considered in the allocation process as discussed above. Gross load allocations include a margin of safety (MOS) needed to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. The gross load allocations in this report incorporated an explicit MOS of 10% to account for uncertainty in the long-term average annual flow values from the gauged data at Station 10308800. The Gross Load Allocation equation is as follows:

Gross Load Allocation (lbs/day) = Average Allowable Load (lbs/day) x 0.90

Table 15. Total Recoverable Nickel Load Allocations for Bryant Creek at California-Nevada Stateline

Parameter	Target Concentration/Level and Most Restrictive Use	Average Daily Stream flow, cubic feet per second	Average Allowable Load, pounds per day	Gross Load Allocation, pounds per day
Total Recoverable Nickel	13.4 µg/l Municipal or Domestic Supply	8.63	0.62	0.56

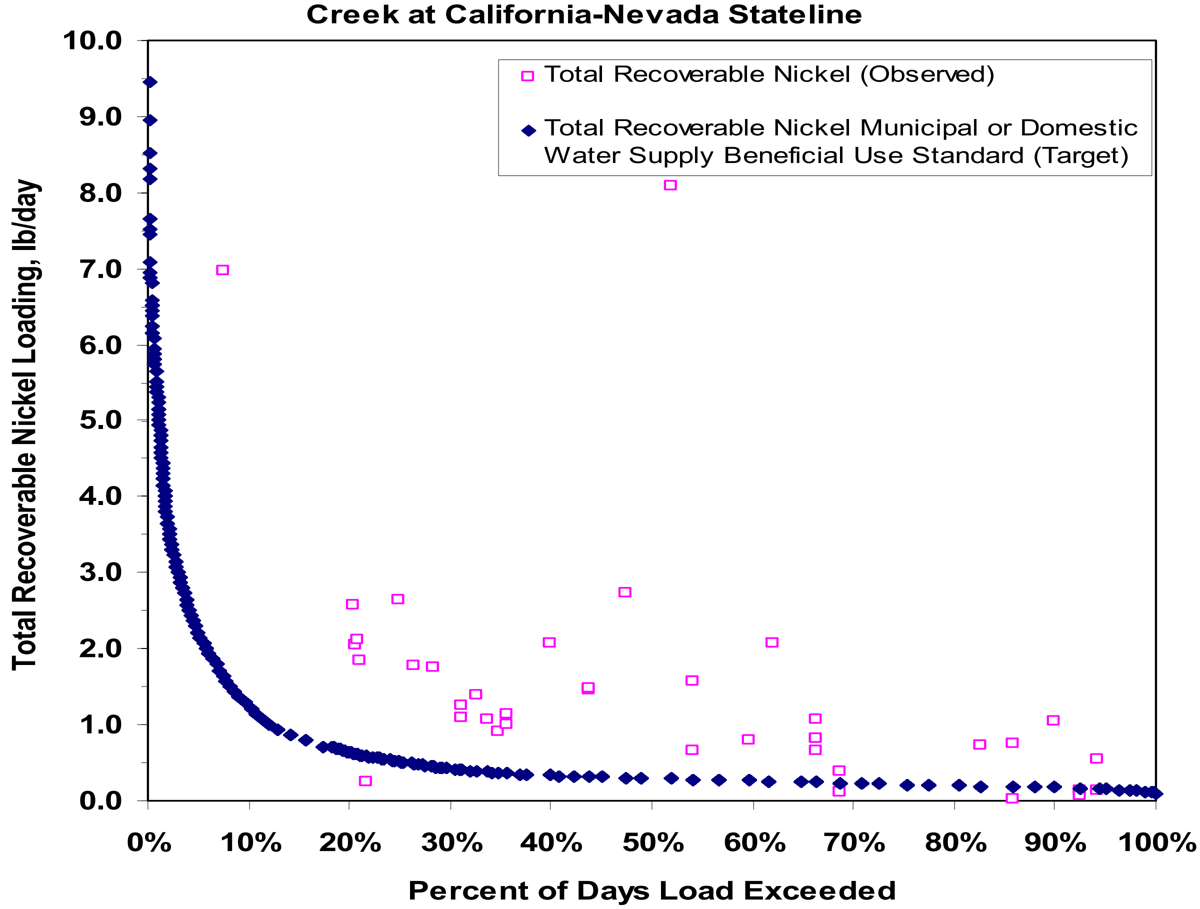
The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This can be readily accomplished through the use of load duration curves presented in Figure 13.

The gross load allocation duration curves are generated by applying target concentrations to the daily stream flow data, along with a margin of safety, to calculate allowable daily loads; and represent the gross load allocations over the historic flow range. Because most sites in Nevada lack sufficient monitoring data, the ability to determine actual historic loads and load reductions is limited at this time. However, by plotting known historic "grab" sample data against the load duration curves, one can better understand the conditions under which the load allocations are exceeded.

For Bryant Creek, target concentrations for total recoverable nickel obtained from Table 14, were applied to daily stream flow data obtained from USGS flow gauge #10308800. A 10% margin of safety was utilized to calculate gross allowable daily loading for total dissolved and total recoverable copper. Actual grab sample data for nickel, collected by CRWQCB (Station 25) between 1984 and 2001 was plotted against the load duration curves.

From Figure 13, observed total recoverable nickel loadings were above the target loadings throughout the entire flow range.

Figure 13. Total Recoverable Nickel Loading Curve for Bryant Creek at California-Nevada Stateline



3

As stated earlier in Section 1.3, the Bryant Creek TMDL represents a "phased" approach to the adoption and implementation of the TMDL for total recoverable nickel. Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information, provide estimates of existing loads and load reductions, identify natural nickel sources and if necessary, revise the TMDL. In addition, as more data is collected, NDEP-BWQP will determine if the removal of total recoverable nickel from the 303(d) List for future listing cycles is justified.

Note that the attainment of water quality standards for Bryant Creek is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to maintain compliance with the total recoverable nickel water quality standards and the TMDL.

Although the Nevada State Laboratory (NSL) has the analytical capabilities, NDEP-BWQP has not requested NSL to analyze for nickel. As stated earlier, this lack of nickel data prohibits NDEP-BWQP from adequately determining compliance with the nickel BUS for Bryant Creek at Doud Springs. As a result, NDEP-BWQP has had to on CRWQCB data for compliance demonstration purposes. It is recommended that NDEP-BWQP expand their analytical request suite to include total recoverable and total dissolved nickel.

3.5 Turbidity and Total Suspended Solids

3.5.1 Problem Statement

Attempts to quantify and identify sources of turbidity and total suspended solids impairment to Bryant Creek are not possible at this time. Furthermore, accurate characterization of creek loadings cannot be determined due to the nature of the loads and the lack of available monitoring data. Turbidity and total suspended solids increase with increasing flow, but because of the sporadic nature of these loads, it is difficult to estimate average annual loads. For this reason, no attempt was made to further quantify historic turbidity and total suspended solids loads to Bryant Creek.

Table 16, Figure 14 and Figure 15 summarize turbidity and total suspended solids data as collected by NDEP-BWQP since 1997. Note that CRWQCB does not sample for turbidity and total suspended solids at Station 25.

Table 16. Summary of Turbidity and Total Suspended Solids Water Quality Standards and Historical Data

Parameter	Bryant Creek at Doud Springs (NDEP/STORET #310592)	
Pollutant	Turbidity	Total Suspended Solids
Most restrictive beneficial use	Aquatic Life	Aquatic Life
Period of Record	1997-2001	1997-2001
Standard	10 NTU	25 mg/l
Count	24	24
% Exceedences	46%	29%
Average	23.87	25.75
Median	11.4	16
Minimum	2.8	0
Maximum	108.1	96

Exceedence of the turbidity standard occurred 46% of the time during the 1997 through 2001 monitoring period. As would be expected, highest observed exceedences typically occurred during the spring when run-off is typically higher.

Exceedence of the total suspended solids standard occurred 29% of the time during the same monitoring period. As is expected, highest exceedences typically occurred during the spring when run-off is typically higher.

Since July 1999, both standards have only been exceeded once each. Both occurred simultaneously in March 2001. Improvements to the existing evaporation ponds and impoundment areas at the Leviathan Mine site appear to have minimized the frequency of turbidity and TSS exceedences.

An attempt was made to correlate stream flow data from the USGS-Doud Springs monitoring site with turbidity and total suspended solids. It was concluded that a poor correlation existed between stream flow and both parameters.

Figure 14. Turbidity - Bryant Creek at Doud Springs (NDEP/STORET #310592)

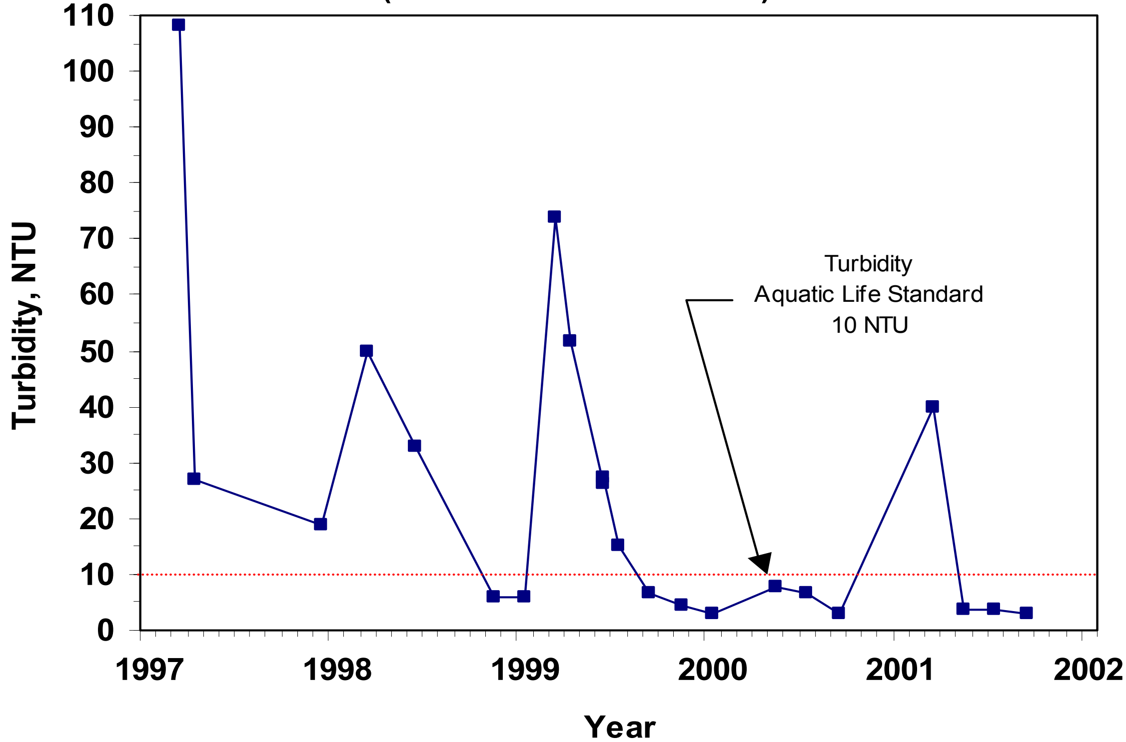
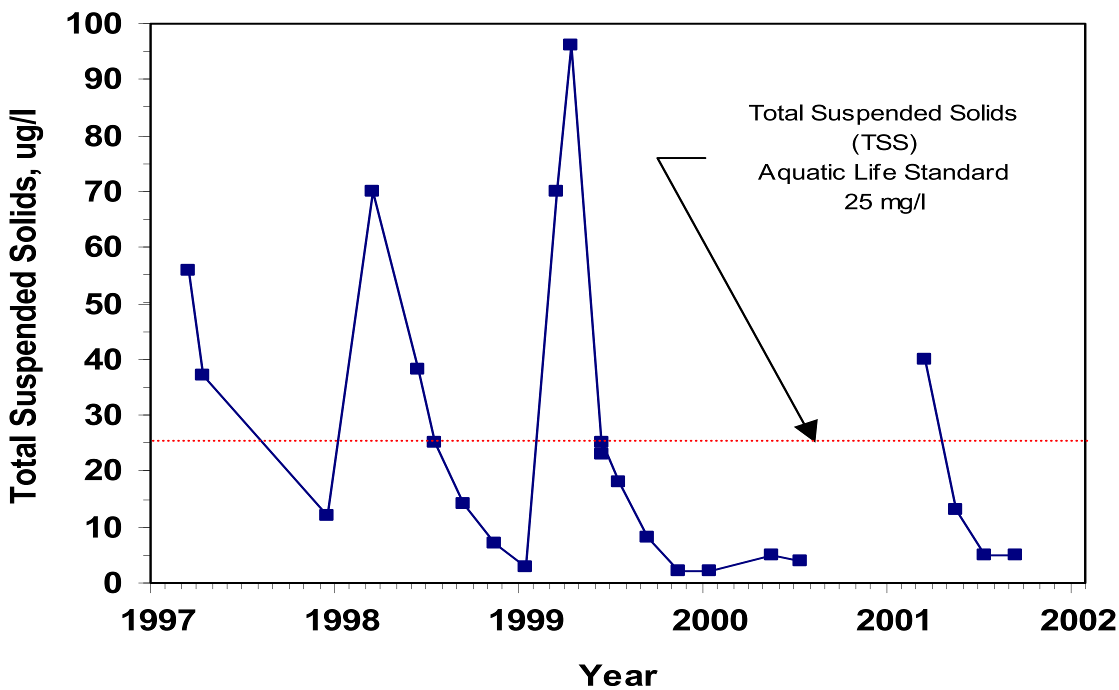


Figure 15. Total Suspended Solids - Bryant Creek at Doud Springs (NDEP/STORET #310592)



3.5.2 Target Analysis

Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards. According to the U.S. EPA (1999), one of the primary goals of target analysis are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

As discussed earlier, NAC 445A.148 provides numeric criteria for turbidity and total suspended solids in Bryant Creek. These standards have been set at certain levels as needed to ensure continued support of the designated beneficial uses. The ultimate goal of this Bryant Creek TMDL is to support these uses through compliance with the numeric standards shown in Table 17.

Table 17. Turbidity and Total Suspended Solids Target Concentrations/Levels for Bryant Creek

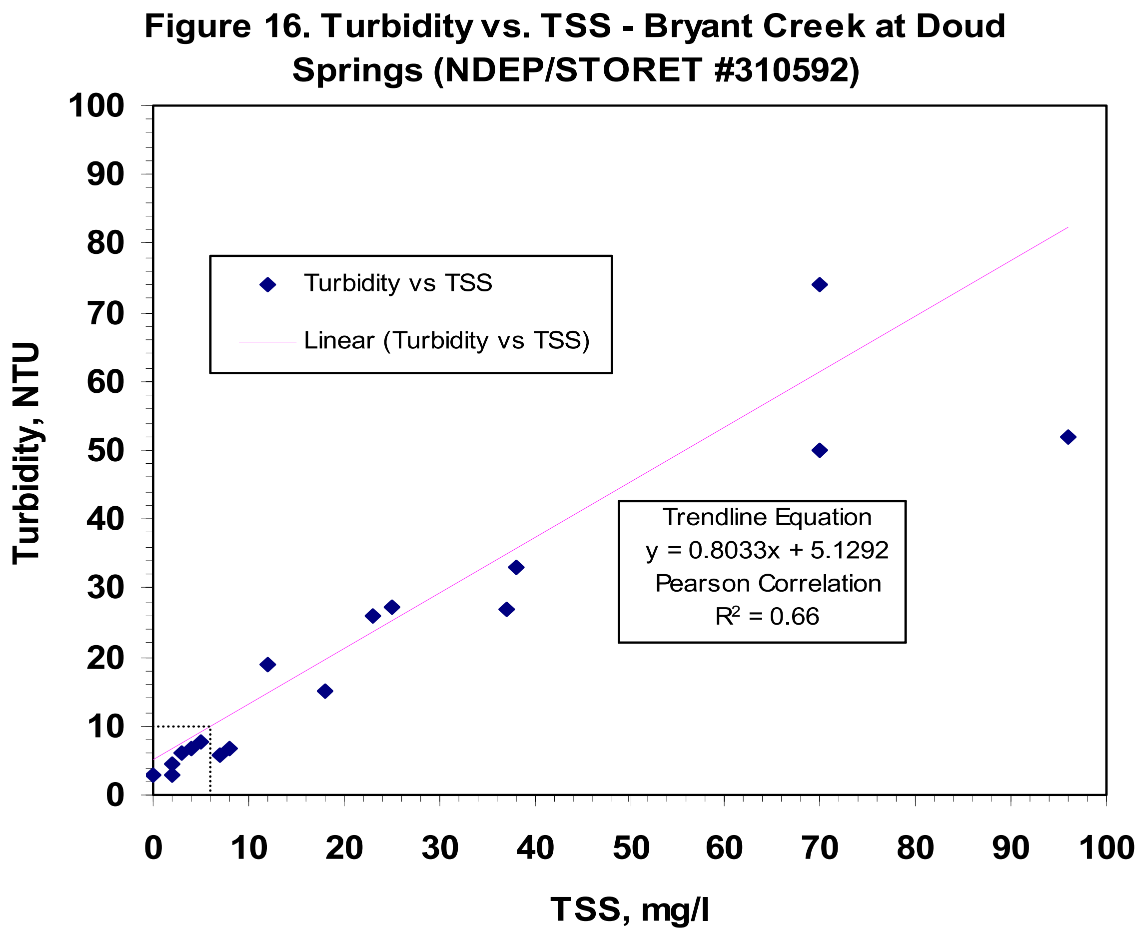
Parameter	Most Restrictive Beneficial Use	Numeric Target	Comments
Turbidity	Aquatic Life	10 NTU Use 6.0 mg/l Total Suspended Solids as surrogate. See comments.	For Bryant Creek, Total Suspended Solids is used as a "surrogate" for Turbidity. From Figure 18, at a TSS concentration of 6.0 mg/l, Turbidity is approximately 10 NTU.
Total Suspended Solids	Aquatic Life	6.0 mg/l	Compliance with the TSS Numeric Target of 6.0 mg/l will insure compliance with the 10 NTU Turbidity standard.

The turbidity standard of measurement (NTU) is unique in the fact that it is not directly amenable to any loading equation. Because of this, the total suspended solids (TSS) concentration has been used as a "surrogate" for turbidity. Previous experience has shown that turbidity and TSS correlate favorably. From Figure 16, at a TSS concentration of 10 mg/l, turbidity is approximately 10 NTU. The Pearson Correlation Coefficient (R^2) is approximately 0.66, which confirms this relationship to be in the acceptable range.

3.5.3 Pollutant Load Capacity and Allocation

In development of a TMDL, allowable allocations needed to meet water quality standards are to be defined for the various sources. Total load allocation is defined as the sum of waste load allocations to point sources, non-point and natural background sources. A margin of safety is included in the analysis, with consideration given to seasonal variations and critical conditions.

The goal of a TMDL is to allocate pollutant loads, determine the necessary load reductions and (through its implementation plan) define a set of actions such that the load reductions will be achieved and water quality standards will be met. With no identifiable sources in Nevada, the water quality standards for turbidity and total suspended solids are only achievable through actions taken in California. Therefore only gross (point, non-point and natural source allocations combined) load allocations have been set for the Nevada-California state line (as measured at USGS gauging station 10308800).



Allocations for turbidity and total suspended solids are summarized in Table 17. The "Average Allowable Load" values were calculated using the following equation:

Avg. Allowable Load (lbs/day) = Target concentration (mg/l) x Avg. Daily Flow (cfs) x 5.394

A margin of safety and seasonal variations were considered in the allocation process as discussed below. Gross load allocations include a margin of safety (MOS) needed to account for uncertainty in determining the relationship between discharges of pollutants and impacts on water quality. The gross load allocations in this report incorporate an explicit MOS of 10% to account for uncertainty in the long-term average annual flow values from the gauged data at Station 10308800. The Gross Load Allocation equation is as follows:

Gross Load Allocation (lbs/day) = Average Allowable Load (lbs/day) x 0.90

The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This can be readily accomplished through the use of load duration curves presented in Figure 17.

The gross load allocation duration curves are generated by applying target concentrations to the daily stream flow data, along with a margin of safety, to calculate allowable daily loads; and represent the gross load allocations over the historic flow range. Because most sites in Nevada lack sufficient monitoring data, the ability to determine actual historic loads and load reductions is limited at this time. However, by plotting known historic "grab" sample data against the load duration curves, one can better understand the conditions under which the load allocations are exceeded.

For Bryant Creek, target concentrations for total suspended solids obtained from Table 18, were applied to daily stream flow data obtained from USGS flow gauge #10308800. A 10% margin of safety was utilized to calculate gross allowable daily loading for total suspended solids. Actual grab sample data for total suspended solids, collected by NDEP-BWQP (STORET #310592) between March 1997 and November 2001 was plotted against the load duration curves.

Table 18. Turbidity and Total Suspended Solids Gross Load Allocations for Bryant Creek at California-Nevada Stateline

<table>
<tr><th>Parameter</th><th>Target Concentration/Level and Most Restrictive Use</th><th>Average Daily Stream flow, cubic feet per second</th><th>Average Allowable Load, pounds per day</th><th>Gross Load Allocation, pounds per day</th></tr>
<tr><td>Turbidity</td><td>10 NTU
(6.0 mg/l Totals Suspended Solids)

Aquatic Life</td><td rowspan="2">8.63</td><td rowspan="2">279.30

(Total Suspended Solids)</td><td rowspan="2">251.37

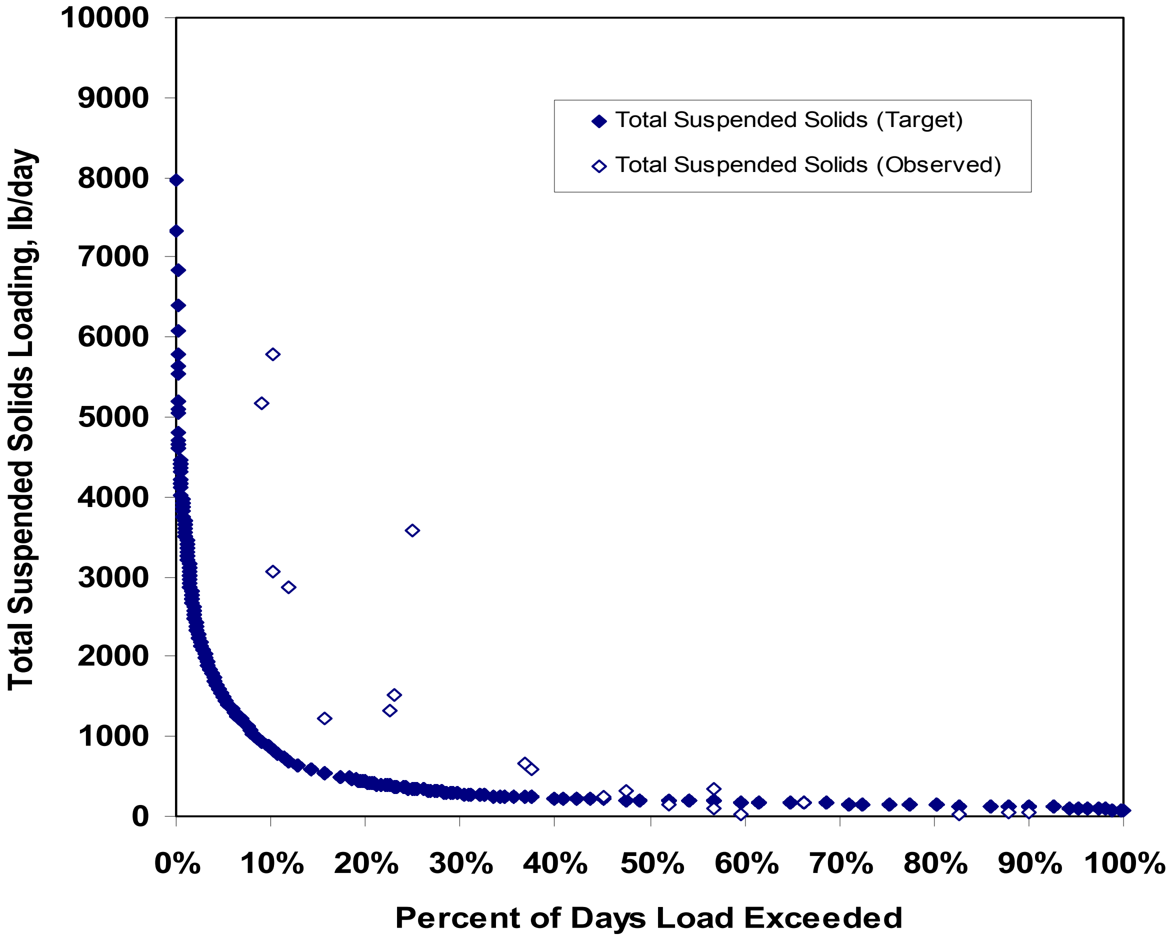
(Total Suspended Solids)</td></tr>
<tr><td>Total Suspended Solids</td><td>6.0 mg/l
Aquatic Life
(To maintain compliance with Turbidity standard)</td></tr>
</table>

From Figure 19, observed total suspended solids loadings were above the target loadings for high and intermediate flows but below the target loadings for periods of low flows. The high loadings can be attributed to several decades of stream bank erosion and other watershed sources.

3.5.4 Future Needs

As stated earlier in Section 1.3, the Bryant Creek TMDL represents a "phased" approach to the adoption and implementation of the TMDL for turbidity and total suspended solids. Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information, provide estimates of existing loads and load reductions, identify sources of sediment impairment and its effect on aquatic life. In addition, as more data is collected and evaluated, NDEP-BWQP will revise the TMDL if necessary or determine if the removal of turbidity and/or total suspended solids from the 303(d) List for future listing cycles is justified.

Figure 17. Total Suspended Solids Loading for Bryant Creek at California-Nevada Stateline



Note that the attainment of water quality standards for Bryant Creek is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to maintain compliance with the turbidity and total suspended solids water quality standards and the TMDL.

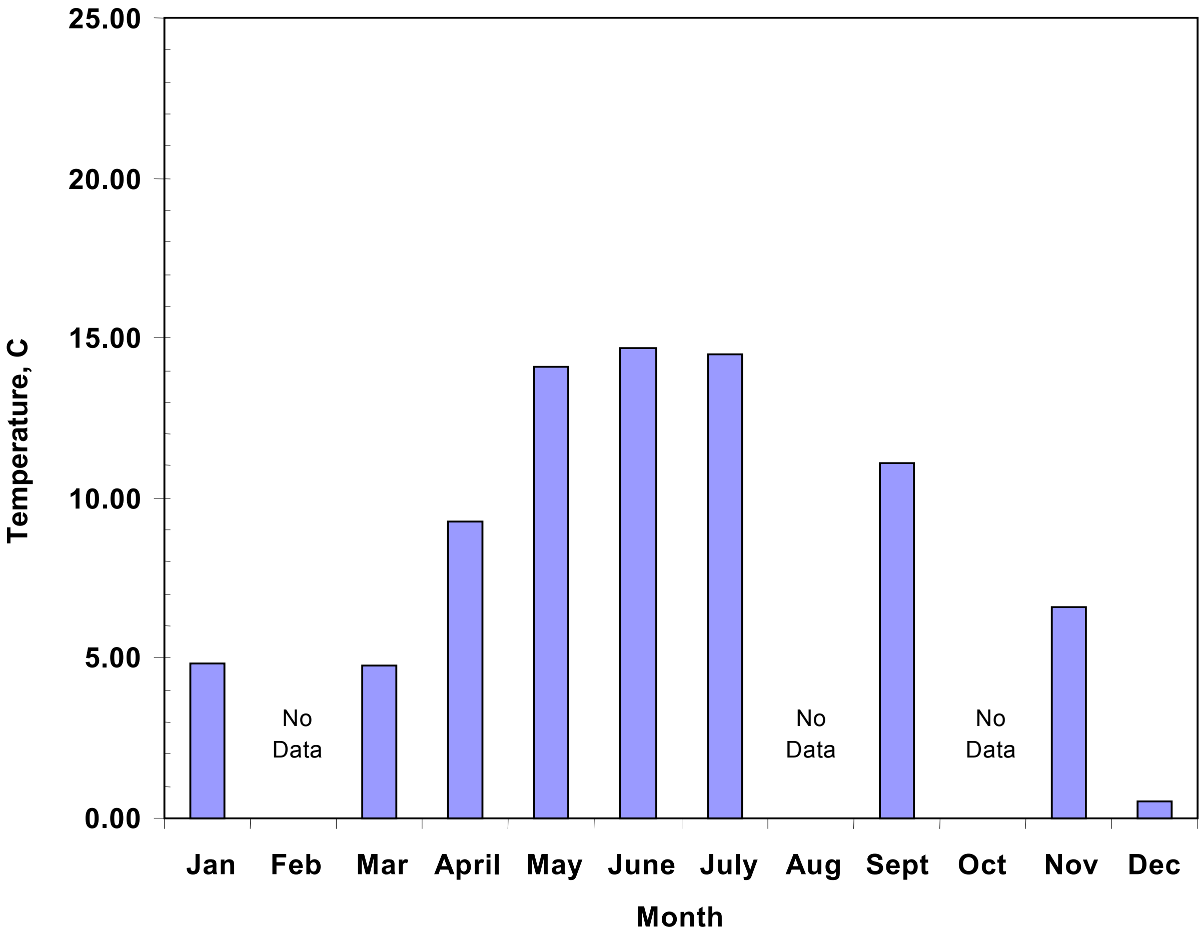
3.6 Temperature

3.6.1 Problem Statement

Although temperature impairment of a water body is often associated with low flow, the correlation between flow rate and temperature for Bryant Creek is not readily apparent. Bryant Creek temperature data is sporadic for the 1997 through 2001 monitoring period and there is no data is available for the months of February, August and October.

Figure 18 and Table 19 summarize temperature data as collected by NDEP-BWQP since 1997. CRWQCB does not measure temperature at Station 25. Table 19 shows that between 1997 and 2001, the highest observed average monthly temperatures occurred during the months of May, June and July, while the lowest occurred during December. Table 18 shows that between 1997

Figure 18. Average Monthly Temperature For Bryant Creek, 1997 - 2001 (USGS #10308800)



and 2001, average monthly temperature ranged from a low of 0.5 ^{o}C (December 1997) to a high of 18.10 ^{o}C (June 1999). During this period, the seasonal temperature standards were exceeded three times (June 29, 1999, May 23, 2000 and May 29, 2001) or about 13% of the time.

Table 19. Summary of Temperature Water Quality Standards and Historical Data

Parameter	Bryant Creek at Doud Springs (NDEP/STORET #310592)
Most restrictive beneficial use	Aquatic Life
Period of Record	1997-2001
Standard	November – May: 13 ^{o}C
Count	13
Exceedences	2
% Exceedences	15%--See Text
Average	6.72
Median	6.4
Minimum	0.50
Maximum	15.00
Period of Record	1997-2001
Standard	June: 17 ^{o}C
Count	3
Exceedences	1
% Exceedences	33%
Average	14.67
Median	16.3
Minimum	9.6
Maximum	18.1
Period of Record	1997-2001
Standard	July: 21 ^{o}C
Count	4
Exceedence	0
% Exceedences	0%
Average	14.48
Median	14.30
Minimum	12.90
Maximum	16.40
Period of Record	1997-2001
Standard	August - October: 22 ^{o}C
Count	4
Exceedence	0
% Exceedences	0%
Average	12.30
Median	12.60
Minimum	8.00
Maximum	16.00
Period of Record	1997-2001
Total Count	24
Exceedences	3
% Exceedences	13%--See Text
Average	9.94
Median	9.60
Minimum	0.50
Maximum	18.10

A closer examination of the Bryant Creek flow data has indicated that two of the exceedences of the temperature standard occurred during periods of extreme low flow on May 23, 2000 and May 29, 2001. The average daily flow for May 23, 2000 was 3.8 cu ft/sec. During the last 30 years, May flows have been lower than this only 9% of the time. The average daily flow for May 29, 2001 was 2.6 cu ft/sec. Over the last 30 years, May flows have been lower than this less than 1% of the time. Furthermore, NAC 445A.121(8) states:

> *"The specified standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of extreme high or low flow. Where effluents are discharged to such waters, the discharges are not considered a contributor to substandard conditions provided maximum treatment in compliance with permit requirements is maintained."*

Because of the two May exceedences occurred during periods of extreme low flow, NDEP-BWQP has concluded that the two May events should not be utilized for 303(d) listing purposes. Therefore, the total number of documented temperature exceedences for the 1997 through 2001 reporting period is one (June 29, 1999). This equates to a temperature exceedence approximately 4% of the time. Based on the 303(d) listing rationale, NDEP-BWQP has concluded that Bryant Creek is not impaired for temperature at this time and no TMDL and load allocations are needed.

3.6.2 Future Needs

Bryant Creek will continue to be monitored for temperature in an effort to identify and delineate sources of temperature excursions or spikes.

4.0 Summary

Section 303(d) of the Clean Water Act requires each state to develop a list of water bodies that need additional work beyond existing controls to achieve or maintain water quality standards, and submit an updated list to the Environmental Protection Agency (EPA) every two years.

Bryant Creek is a tributary of the East Fork Carson River. The creek originates in California on the eastern slopes of the Sierra Nevada Mountains in northeast Alpine County. For over 50 years, acid mine drainage from the Leviathan Mine has impacted the waters of Leviathan and Bryant creeks, creating significant water quality concerns. This drainage is primarily the result of repeated failure of the tailings impoundment walls and pond overflow.

Bryant Creek was initially included on Nevada's 1998 303(d) List due to water quality concerns related to copper, iron and nickel. With the 2002 303(d) List, the Bryant Creek listing was expanded to include arsenic, turbidity and total suspended solids. After further evaluation of the data, most of the temperature standard exceedences were found to have occurred during periods of low flow. Pursuant to NAC 445A.121(8), NDEP-BWQP has concluded that since these temperature exceedences occurred during periods of low flow, they are not subject to any 303(d) listing nor TMDL requirements.

The Bryant Creek TMDL is a "phased" approach to TMDL adoption and implementation, for the parameters listed above. A phased approach is used in situations where data and information needed to determine the TMDL and associated load allocations are limited. A phased approach enables the adoption and implementation of a TMDL while collecting additional information.

Under this phased approach, NDEP-BWQP will continue to collect additional monitoring information, evaluate the information and provide estimates of existing loads and load reductions (if possible). In addition, as more data is collected and evaluated, NDEP-BWQP will revise the TMDL if necessary or determine if the addition of temperature to the 303(d) List as needed.

Attainment of water quality standards and appropriateness of the designated beneficial uses for Bryant Creek is dependent on the activities and actions taken by the CRWQCB. NDEP-BWQP will work with CRWQCB and EPA Region IX in an effort to maintain compliance with the temperature standards.

References

Las Vegas Sun. “EPA begins first cleanup of toxic Leviathan Mine.” September 13, 2000.

U.S. Environmental Protection Agency. “EPA Proposes Leviathan Mine for Superfund List.” Fact Sheet. November 1999.

U.S. Environmental Protection Agency. “NPL Site Narrative at Listing.” Federal Register Notice from EPA Superfund Website. May 11, 2000.

Appendix A

Water Quality and Quantity Data at Selected Monitoring Stations

Table A-1. Historical Data Bryant Creek at Doud Springs (NDEP/STORET 310592)

Date	Temperature C	Hardness (as $CaCO_3$)	Arsenic (µg/l)		Copper (µg/l)		Iron (µg/l)		Total Suspended Solids (mg/l)	Turbidity (NTU)	Stream flow (cfs)
			Dissolved	Total	Dissolved	Total	Dissolved	Total			
Minimum Detection Limit (MDL)			*3.0* ***µg/l***		*20.0* ***µg/l***		*50.0* ***µg/l***		*10.0 mg/l*	*0.4 NTU*	
1/6/97		1753		220		110		18,560	56.0		19.0
4/30/97	9.0	86		27		20		3,760	37.0	27.0	17.0
7/22/97		144		5		< 20		2,650	12.0		4.8
12/4/97	0.5	147	<3.0	6		< 20		2,940	70.0	19.0	4.3
3/20/98	6.4	117		85	< 20	54	359	9,060		50.0	17.0
6/15/98	16.3	93	4.0	79		40		7,440	38.0	33.0	14.0
7/21/98	16.4	129	4.0	9	< 20	20	916	3,790	25.0		4.9
9/15/98	16.0	143		6	< 20	< 20	97	533	14.0		4.2
11/17/98	4.8	125	<3.0	4		< 20		1,250	<10.0	5.8	4.8
1/12/99	3.4	116	8.0	<3	< 20	20	320	870	<10.0	6.0	4.5
3/16/99	4.6	142	<3.0	135	< 20	60	230	10,000	70.0	74.0	7.7
4/15/99	9.6	95	<3.0	14	< 20	30	1230	7,700	23.0	51.8	25.0
6/2/99	9.6	95	<3.0	6	< 20	< 20	540	3,980	96.0	26.1	11.0
6/29/99	18.1	125		4	< 20	< 20	740	3,740	25.0	27.3	4.8
7/20/99	13.5	123	4.0	4	< 20	< 20	330	2,060	18.0	15.2	3.8
9/14/99	12.7	247	4.0	37	< 20	< 20	120	600	<10.0	6.6	4.1
11/22/99	6.6	115	<3.0	11		< 20		300	<10.0	4.8	4.0
1/11/00	6.2	111	4.0	<3	< 20	< 20	90	250	<10.0	3.0	6.0
5/23/00	15.0	114	5.0	5	< 20	< 20	250	940		7.6	4.4
7/18/00	15.1	104	6.0	6	< 20	< 20	230	660	<10.0	6.6	2.0
9/12/00	12.5	152	5.0	5	< 20	< 20	70	210	<10.0	2.8	2.0
11/11/00		152	5.0	5	< 20	< 20		210			2.0

Table A-1. Historical Data Bryant Creek at Doud Springs (NDEP/STORET 310592)--continued

Date	Temperature C	Hardness (as $CaCO_3$)	Arsenic (µg/l)		Copper (µg/l)		Iron (µg/l)		Total Suspended Solids (mg/l)	Turbidity (NTU)	Stream flow (cfs)
			Dissolved	Total	Dissolved	Total	Dissolved	Total			
Minimum Detection Limit (MDL)			*3.0* ***µg/l***		*20.0* ***µg/l***		*50.0* ***µg/l***		*10.0 mg/l*	*0.4 NTU*	
1/9/01											
3/20/01	7.1	156	<3.0	8.0	<20	20		4,160	40.0	40.0	
5/29/01	13.2	109	3.0	5.0	<20	20		410	13.0	3.7	
7/17/01	12.9	101	5.0	6.0		<20		430	<10.0	3.7	
9/25/01	8.0								<10.0	3.0	
11/27/01											

Table A-2. Historical Data Bryant Creek above Confluence with East Fork Carson River (NDEP/STORET 310009)

Date	Total Copper (µg/l)	Total Iron (µg/l)
Minimum Detection Limit (MDL)	*20.0* ***µg/l***	*50.0* ***µg/l***
20-Jan-77	< 20.0	
8-Nov-78	20	6,150
29-Jul-82	< 20.0	1,220
23-Jul-91	< 20.0	570

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)

Date	Total As, ug/l	Total Cu, ug/l	Total Fe, ug/l	Total Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)	*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
8/1/1984	150.00		21000		
10/2/1984	100.00		33000	320.00	
11/16/1984	20.00		20000	160.00	
7/1/1985	10.00		14000	200.00	
9/3/1985	20.00		11000	200.00	
11/1/1985	10.00		7400	100.00	
5/28/1986	83.00		18000	100.00	
7/14/1986	24.00		6600	100.00	
8/15/1986	7.00		5300	100.00	
9/18/1986	5.00		7800	200.00	
10/20/1986	4.00		3600	100.00	
6/10/1987	7.00		4200	100.00	
8/21/1987	3.00		2500	100.00	
10/6/1987	4.00		2200	100.00	
3/30/1988	20.00		7800	70.00	
6/2/1988	4.00		3200	50.00	
8/1/1988	4.00		1500	50.00	
10/21/1988	14.00		4900	140.00	
5/18/1989	170.00		12000	150.00	
7/7/1989	4.00		3400	60.00	
8/14/1989	4.00		1000	50.00	
9/6/1990	5.00		690	20.00	
8/23/1991	5.00		1300	20.00	
10/31/1991	4.00		2700	5.00	
4/7/1993	69.00		210000	110.00	19.06
5/18/1993	35.00		7700	20.00	8.16
6/28/1993	16.00		10000	130.00	1.87
9/8/1993	4.0		2900	73.0	1.40

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)--continued

Date	Total As, ug/l	Total Cu, ug/l	Total Fe, ug/l	Total Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)	*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
1/15/1994	1500.0		110000	1500.0	3.60
1/18/1994	700.0		74000	910.0	2.24
3/11/1994	44.0	100.0	6200	180.0	3.56
4/1/1994	110.0		14000	190.0	2.30
4/18/1994	24.0	27.0	7500	74.0	0.16
12/29/1994				68.0	1.06
3/18/1998	190.0	91.0	11000	150.0	3.65
4/20/1998	67.0	67.0	14000	51.0	16.70
2/3/1999	160.0	110.0	18000	340.0	11.72
3/16/2000	17.0	27.0	4700	5.0	4.42
3/23/2000	12.0		5100	62.0	3.23
3/31/2000	13.00	14.0	5400	47.0	2.06
4/6/2000	6.7	8.5	3400	37.0	2.70
4/14/2000	9.3	9.5	3900	40.0	2.41
4/17/2000	8.3	6.8	3700	44.0	8.80
4/28/2000	7.8	6.4	3800	30.0	23.00
4/28/2000	10.0	<2.5	3800	34.0	8.79
5/5/2000	8.6	5.0	3100	56.0	2.33
5/12/2000	<5.0	7.3	3700	57.0	
5/30/2000	5.0	5.5	1900	53.0	
6/15/2000	<5.0		2100	48.0	3.70
7/31/2000	5.0		310	41.0	7.00
8/29/2000	<5.0		680	45.0	5.90
9/27/2000	5.0	5.0	1100	<2.5	5.00
10/30/2000	5.0	5.0	1800	36.0	7.00
11/28/2000	5.0	5.0	840	29.0	6.50
12/28/2000	5.0	5.0	1400	41.0	5.20
1/26/2001	5.0	5.0	1300	38.0	3.80
3/1/2001	5.0	5.0	1100	33.0	
3/27/2001	22.0	12.0	3200	42.0	3.10
3/27/2001	5.0	13.0	2800	50.0	3.00
4/24/2001	26.0	29.0	4600	38.0	2.40
4/24/2001	8.1	12.0	17000	43.0	1.40
4/25/2001	5.0	30.0	6200	34.0	1.10
5/29/2001	5.0	5.0	1900	33.0	1.80
6/27/2001	5.0	5.0	<100	5.4	1.50
6/27/2001	5.0	5.0	1800	20.0	
7/26/2001	5.0	5.0	330	9.3	
7/26/2001	5.0	5.0	<100	5.0	
8/25/2001	<5.0	5.9	440	11.0	

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)--continued

Date	Hardness as $CaCO_3$, mg/l	Dissolved As, ug/l	Dissolved Cu, ug/l	Dissolved Fe, ug/l	Dissolved Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)		*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
10/2/1984						
11/16/1984						
7/1/1985						
9/3/1985						
11/1/1985						
5/28/1986						
7/14/1986						
8/15/1986						
9/18/1986						
10/20/1986						
6/10/1987						
8/21/1987						
10/6/1987						
3/30/1988						
6/2/1988						
8/1/1988						
10/21/1988						
5/18/1989						
7/7/1989						
8/14/1989						
9/6/1990						
8/23/1991						
10/31/1991						
4/7/1993						19.06
5/18/1993						8.16
6/28/1993						1.87
9/8/1993						1.40
1/15/1994						3.60
1/18/1994						2.24
3/11/1994		<5.0		1200	190.0	3.56
4/18/1994		<5.0	3.0	410	62.0	0.16
6/23/1994		<5.0	<2.5	850	74.0	
9/14/1994		<5.0	10.0	120	41.0	
12/29/1994		<5.0		990		1.06
3/17/1995		<5.0		2000	70.0	
4/25/1995		5.8		1100	48.0	
5/19/1995		100.0		520	61.0	
6/22/1995		100.0		4300	120.0	
8/11/1995		<5.0		1400	100.0	

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)--continued

Date	Hardness as $CaCO_3$, mg/l	Dissolved As, ug/l	Dissolved Cu, ug/l	Dissolved Fe, ug/l	Dissolved Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)		*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
8/17/1995		<5.0		300	110.0	
9/14/1995		<5.0		490	97.0	
10/19/1995		<5.0	50.0	670	100.0	
11/28/1995		<5.0		1200	100.0	
1/12/1996		5.0		2800	180.0	
2/7/1996				4400	320.0	
3/7/1996		5.0		3900	230.0	
4/5/1996		5.0		660	62.0	
5/7/1996		5.0		100	100.0	
6/4/1996	140.0	<5.0		100	72.0	
7/2/1996	150.0	<5.0		120	73.0	
8/16/1996	170.0	5.0		750	100.0	
10/31/1996	130.0	<5.0	35.0	900	54.0	
12/4/1996	130.0	<5.0		100	100.0	
2/20/1997	150.0	22.0	20.0	2900	200.0	
3/27/1997	87.0	5.0	20.0	100	38.0	
5/12/1997	110.0	5.0	20.0	150	37.0	
8/7/1997	160.0	5.0	20.0	180	48.0	
9/5/1997	150. 0	5.0	20.0	100	47.0	
1/7/1998	150.0	5.0	20.0	690	41.0	
2/13/1998	220.0	140.0	310.0	29000	730. 0	
3/18/1998	160.0	5.0	82.0	2300	160.0	3.65
5/20/1998	97.0	5.0	20.0	200	44.0	
6/18/1998	90.0	5.0	20.0	100	33.0	
7/31/1998	110.0	100.0	7.2	570	82.0	
8/27/1998	170.0	50.0	5.0	1000	83.0	
10/2/1998	170.0	100.0	5.0	210	76.0	
11/3/1998	170.0	<5.0	<2.5	500	59.0	
12/4/1998	150.0	<5.0	3.2	800	63.0	
1/13/1999	170.0	5.0	5.0	850	50.0	
1/21/1999	150.0	180.0	500.0	14000	1300.0	
2/3/1999	340.0	5.0	100.0	5000	330.0	11.72
3/12/1999	190.0	5.0	55.0	2300	190.0	
4/20/1999	180.0	12.0	6.7	1400	41.0	
5/19/1999	96.0	5.0	5.0	100	32.0	
6/15/1999	94.0	5.0	5.0	820	64.0	
7/28/1999	137.61	5.0	5.0	800	64. 0	
8/19/1999	170.01	5.0	5.0	240	53.0	

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek

(CRWQCB STATION 25)—continued

Date	Hardness as $CaCO_3$, mg/l	Dissolved As, ug/l	Dissolved Cu, ug/l	Dissolved Fe, ug/l	Dissolved Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)		*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
9/3/1999	151.71	5.0	10.0	2400	110.0	
9/8/1999	196.69	5.0	5.0	700	75.0	
9/15/1999	228.32	5.0	5.0	5900	130.0	
9/25/1999	230.69	5.0	5.0	250	100.0	
9/28/1999	552.67	<5.0	5.0	2200	100.0	
10/9/1999	448.67	<5.0	5.0	1200	72.0	
10/15/1999	190.87	<5.0	5.0	4000	40.0	
10/21/1999	160.16	<5.0	5.0	1400	55.0	
11/28/1999	173.39	<5.0	5.0	1200	50.0	
12/21/1999	120.29	<5.0	5.0	710	40.0	
1/28/2000	161.78	<5.0	5.2	1700	54.0	
2/11/2000	151.79	<5.0	5.0	840	43.0	
2/11/2000	151.79	<5.0	5.0	840	43.0	
3/2/2000	154.29	<5.0	5.0	910	49.0	
3/2/2000	154.29	<5.0	5.0	910	49.0	
3/16/2000	160.91	<5.0	5.0	170	50.0	4.42
3/23/2000	142.68	<5.0	5.0	230	44.0	3.23
3/31/2000	137.69	<5.0	7.8	530	40.0	2.06
4/6/2000	113.65	<5.0	5.0	520	35.0	2.70
4/14/2000	114.91	<5.0	5.6	100	31.0	2.41
4/17/2000	123.20	5.0	5.0	230	35.0	8.80
4/28/2000	126.08	10.00	5.00	<100	20.0	23.00
4/28/2000	126.08	10.00	10.0	<100	23.0	8.79
5/5/2000	135.19	<5.0	5.0	420	47.0	2.33
5/12/2000	135.19	<5.0	7.1	1200	53.0	
5/30/2000	135.19	<5.0	10.0	300	42.0	
6/15/2000	142.68	<5.0	5.0	140	38.0	3.70
7/31/2000	142.68	<5.0		100	31.0	7.00
8/29/2000	142.68			<100	46.0	5.90
9/27/2000	142.68	<5.0	5.0	<100	<2.5	5.00
10/30/2000	142.68	<5.0	5.0	270	32.0	7.00
11/28/2000	142.68	<5.0	5.0	200	33.0	6.50
12/28/2000	142.68	<5.0	5.0	470	32.0	5.20
1/26/2001	142.68	5.0	5.0	590	33.0	3.80
3/1/2001	142.68	<5.0	15.0	100	30.0	
3/27/2001	142.68	<5.0	5.0	750	45.0	3.10
3/27/2001	142.68	<5.0	5.0	<100	<2.5	3.00
4/24/2001	142.68	<5.0	5.0	<100	22.0	2.40
4/24/2001	142.68	<5.0	5.0	<100	16.0	1.40

Table A-3. Historical Data Bryant Creek Below Confluence with Mountaineer Creek

(CRWQCB STATION 25)—continued

Date	Hardness as $CaCO_3$, mg/l	Dissolved As, ug/l	Dissolved Cu, ug/l	Dissolved Fe, ug/l	Dissolved Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)		*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
4/25/2001	142.68	<5.0	5.0	<100	<2.5	1.10
5/29/2001	142.68	<5.0	5.0	<100	12.0	1.80
6/27/2001	142.68	<5.0	26.0	<100	5.0	1.50
7/26/2001	142.68	<5.0	5.0	100	5.0	
7/26/2001	142.68	5.0	5.0	100	16.0	
8/25/2001	142.68	<5.0	5.5	110	13.0	

Table A-4. Historical Data Bryant Creek near Gardnerville, NV (G8307000)

Date	Dissolved Copper (µg/l)	Total Iron (µg/l)
8-May-69	700	29,000

Table A-5. Historical Data Bryant Creek at Bridge below Leviathan Creek (G8307449)

Date	Dissolved Copper (µg/l)	Total Iron (µg/l)
8-May-69	920	33,000

Table A-6. Historical Data Bryant Creek at Mouth (G8306510)

Date	Dissolved Copper (µg/l)	Total Iron (µg/l)
8-May-69	680	33,000